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ABSTRACT

This study is based on two surveys, one mailed to over 23,000 Washington, D.C. area engineers comprising the area membership of eight engineering professional societies and another sent to several thousand area organizations considered likely to employ engineers. In addition to assessing specific needs for various kinds of engineering education, the two surveys also examined the perceived effectiveness of current and past offerings. In designing and analyzing the questionnaire for the survey, previous questionnaires on engineering education needs were studied along with literature on questionnaire design and continuing education needs of engineers. A questionnaire was prepared, reviewed, piloted, and revised (including an appendix with responses). Some of the major conclusions reached are as follows: (1) About two-thirds of the engineers surveyed believed that the education engineering students received would be improved by a shift toward a professional school model; (2) The colleges or universities regarded as being most effective were schools with local main campuses rather than extension campuses of in-state or out-of-state schools; (3) Live programs offered by universities at the place of employment also were considered very effective; and (4) Area employers of engineers generally were supportive of further continuing education for their professional staff and wanted more opportunities. (Author/JN)

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GMU Report 1001

ENGINEERING CONTINUING EDUCATION: NEEDS IN THE GREATER WASHINGTON D. C. METROPOLITAN AREA

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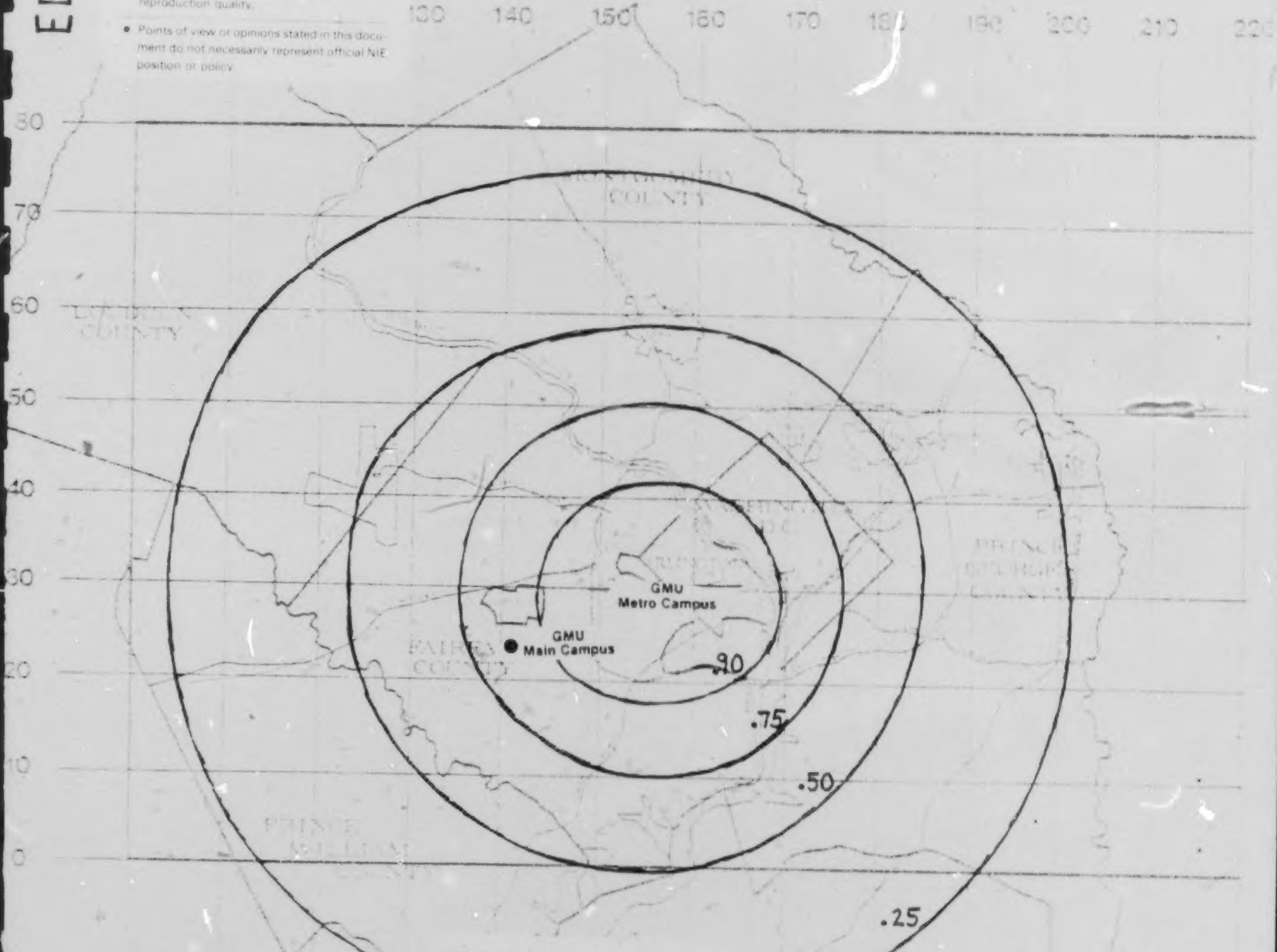
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November 1980

Engineering Continuing Education: Needs in the Greater Washington D.C. Metropolitan Area

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November 1980

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Ralph Byers, Assistant to the Director, Council for Higher Education of Virginia,George Mason University Engineering Advisory Board Members (This Board consists of 22 professional engineers affiliated with area firms or government agencies)

Arthur Kirsch and J.E. Mansfield, George Washington University,

Phillip Melville, National Director, Virginia Society of Professional Engineers,

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Lawrence Welling, Girard Levy and Sandy Newman, Battelle Center for Improved Instruction,

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Engineering Continuing Education: Needs in the Greater Washington D.C. Metropolitan Area

1. Introduction and Conclusions

The continuing education needs of the over 40,000 Washington D.C. Metropolitan Area engineers are very extensive and in some respects not very well satisfied. This is the principal finding of an 18-month study conducted by George Mason University and funded by the National Science Foundation. The study is based on two surveys, one of which was mailed to over 23,000 area engineers--the area membership of eight engineering professional societies.[1] A second survey was sent to several thousand area organizations considered likely to employ engineers.

There are a number of Washington metropolitan area universities offering continuing engineering education including such major institutions as George Washington University and the University of Maryland. Other institutions such as George Mason University have to date provided more limited offerings, although George Mason, for example, does hope to expand in this area particularly in degree/credit programs. Nevertheless, this study should be of benefit to all area continuing engineering education suppliers including universities.

In addition to assessing the specific needs for various kinds of engineering education the two surveys also examine the perceived effectiveness of current and past offerings.

One unique element of the study is a determination of the relative magnitude of various needs for different points on a map, making it possible to see how given needs vary over the entire metropolitan area. This aspect of the study should have wide applicability to other geographic regions and disciplines other than engineering, and may be of use in various kinds of needs-assessments.

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[1] A separate survey of 2000 area physicists is to be reported elsewhere.

Some of the major conclusions reached in the study are as follows:

(1) About two thirds of the engineers surveyed believe that the education engineering students now receive would be improved by a shift towards a professional school model.

(2) As regards their own continuing education, respondents consider colleges or universities to be the preferred supplier even though most no longer want or need further degrees (Over half already have a masters or doctorate.)

(3) The colleges or universities regarded as being most effective are schools with local main campuses rather than extension campuses of in-state or out-of-state schools.

(4) Live programs offered by universities at the place of employment are also considered very effective, not quite as effective as on-campus programs of local universities, but more effective than programs offered by extension campuses.

(5) Few engineers are in a position to relocate to pursue graduate education, even if financial aid were available.

(6) The percentage of engineers who are Virginia residents and who cite a need for graduate education exceeds those for Maryland and Washington D.C. Moreover, programs at area universities within commuting distance are less available according to Virginia residents.

(7) Engineers when asked about obstacles to their seeking further continuing education rank as the four most important: "lack of time", "inconvenient location", "inconvenient time", and "course not available". The latter three would seem to point to some need for improvement in present continuing engineering education practices.

(8) The unavailability of courses is a significant issue since over two thirds of all respondents cited a need for some specific continuing education topics. On many of the requested topics in very great demand, either no or not enough courses are offered.

(9) The needs for different topics vary throughout the metropolitan area in a way that can actually be well represented on "need-contour" maps. These can be generated using the home and work locations of respondents using a technique original to this study.

(10) The need for a particular topic (Microprocessors) as measured in this survey appears to agree well with the actual number of persons enrolling in a course in that topic at all area universities combined. Hence, this survey may offer a way of estimating approximate enrollments.

(11) Area employers of engineers are generally supportive of further continuing education for their professional staff and wish to see such opportunities expanded. The views of these organizations on the relative effectiveness of

various kinds of offerings closely parallel those of the individual engineers.

(12) About half* the employers surveyed financially support the continuing education of their professional staff in part or in full. However, the differing policies of organizations in this regard, plus the high costs of certain types of continuing education (particularly short courses) present a very serious obstacle to those engineers without employer support.

(13) The location of universities offering engineering programs can be examined with reference to the distribution of need throughout the Greater Washington D.C. Metropolitan area. For example, in the figure on the following page we show "need contours" for Maryland residents who requested one or more continuing education topics in this survey. The University of Maryland at College Park would seem on this basis to be particularly well-located to meet the continuing engineering education needs of Maryland residents. Similar contour maps, generated by a method to be discussed later, are shown on pages B12-14 for Washington D.C. and Virginia residents. The four Washington D.C. universities offering engineering degree programs (Catholic, George Washington, UDC, and Howard)

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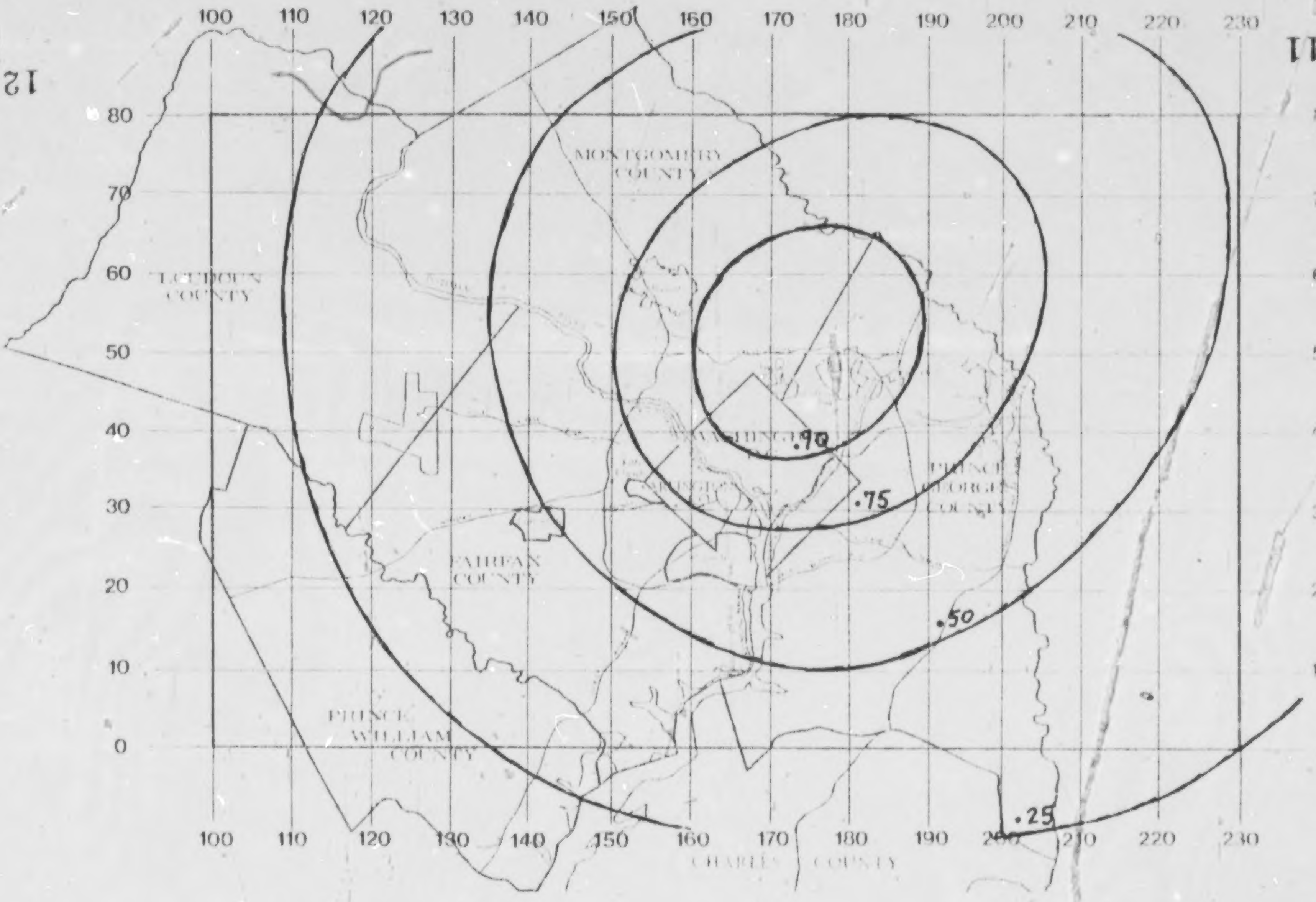
*While about half the organizations financially support continuing education, the fraction of engineers who are supported is certainly greater than one half, since the larger organizations are more likely to be in a position to financially support their employees.

are similarly well-located. There is at present no university offering main campus engineering degree programs in Northern Virginia without residency requirements elsewhere. The main supplier of degree/credit programs (the Virginia Polytech Center at Dulles) is not optimally situated with respect to the need distribution of Virginia residents.

NEED FOR ALL TOPICS COMBINED (MARYLAND RESIDENTS ONLY)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2. Methodology of Surveys

The survey of individual engineers was conducted through mailings to the area membership of eight* professional engineering societies. The eight engineering societies include most of the major engineering specialties. As indicated in the table on page A1, not all engineers of a given type who are employed in this geographic area belong to a professional society. Nevertheless for each of the major specialties well over half the engineers do belong. Moreover, it might be expected that, on the average, non-members of the professional societies would have a considerably lesser interest in formal continuing education than members.

In designing and analyzing the questionnaire for the survey of individuals each of the following steps was taken:

1. Previous questionnaires on engineering education needs conducted by others were studied along with the literature on questionnaire-design and that on continuing education needs of engineers.
2. A draft questionnaire was prepared and circulated to a number of professional engineers for comments. The list of engineers contributing valuable suggestions is to numerous to cite here. (see acknowledgements).
3. Recognizing that any instrument is bound to have imperfections even after careful examination by many persons, we printed only enough questionnaires for one society (A.I.Ch.E.--Chemical Engineering), with the

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*See page A1 for list of societies surveyed.

intention of using this as a pilot. A number of further changes were made in the questionnaire based on the responses of this group. The primary reason for selecting the chemical engineers for the pilot study was that they are the smallest of the eight engineering societies.

4. The final version of the survey of individual engineers (see pages C0-C14) was mailed out to members of the other seven engineering societies. Based on the response from the pilot study of chemical engineers, it was decided to have one single mailing rather than multiple mailings. This decision was made after examining the results of multiple mailings for the Chemical engineers, where it was found that the percentage return rate for two mailings combined was not a very great improvement over that for one. Additionally, the geographic distributions of respondents and their interest in continuing education were not significantly different for the first and second mailings as indicated on page A2. This point would indicate that a single mailing (vs multiple mailings) does not appear to introduce significant biases. Other indications of lack of significant bias in the sample of respondents will be considered later.

5. The information in the returned survey booklets was entered into a HP 3000 computer by two assistants using a data entry program designd to set up a blank version of the questionnaire on the screen of video terminal. The program performed simple on-line checking of information

signaling the operator when specified quantities were out of bounds. Because the questionnaires are lengthy and detailed, many months were required to enter the data into the computer. (The option of sending out mark-sense forms with the survey booklets which would have considerably simplified the data entry task was considered and rejected as being too inconvenient for the person filling out the questionnaire, and hence probably having an adverse effect on the return rate.)

6. A computer program was written to tabulate all items in the survey database. The program allows the user to perform tabulations with selections made on any particular variable, as will be seen later. The key novel feature of the program, i.e. the "CEXY method," will be described in another section.

7. It is recognized that not all issues concerning engineering education needs are susceptible to a simple computer tabulation. Thus, in addition to filling out items on the survey which could be tabulated, respondents were also invited to express their views in writing concerning: (a)the effectiveness of particular continuing education offerings they have taken, (b)ways in which the effectiveness of continuing education offerings might be improved, and (c)omissions or deficiencies in the questionnaire itself. Over 700 respondents included lengthy written comments. In presenting the results of the survey, we have included the gist of many of these

comments as they relate to a particular issue. (see section 10)

Many of the same procedures followed in the development and analysis of the questionnaire used in the individual survey were also used in the organization survey. There were also several important differences:

1. It is difficult to locate a convenient directory of organizations for the entire greater Washington metropolitan area that indicates which organizations are likely to employ engineers (although some individual counties do have industrial directories). Dun's Marketing Services (a division of Dun and Bradstreet, Inc.) can provide mailing labels for all organizations listed on its computer tapes with selections made according to zip code, SIC product code, and company size. The SIC code indicates the particular product or service that a company provides. Clearly, companies having some SIC codes are much more likely to employ engineers than others. A set of mailing labels was obtained from Dun's Marketing Services for all private organizations in Greater Washington Metropolitan area zip codes which are listed under a wide range of "reasonable" SIC codes, and which also employ ten or more persons. A separate listing was compiled of federal government agencies likely to employ engineers. The number of private organizations from the Dun tapes was 2048; the number of government agencies was 95.
2. The number of questionnaires returned from organizations was considerably smaller than that for individuals. It

was therefore decided to analyze these results by hand rather than by computer.

For reasons to be discussed later, we believe the results from the organization survey to be much less significant than those from the individual survey. Therefore, considerably more discussion will be devoted to the individual survey (the following eight sections). The organization survey is discussed in section 11.

3. Characteristics of Respondents (Individual Survey)

The Washington D.C. metropolitan area with its three different governmental jurisdictions and its large concentration of federal government employees is unique. Accordingly, the statistical profile of engineers employed in this area also has some unique elements. The tables on pages A3-A14 provide a thorough picture of the characteristics of the 5377 respondents to this survey. Here we briefly summarize a few of the items from these tables.

Two thirds of the survey respondents are members of one of the three largest engineering societies: electrical, civil or mechanical with the largest group (38.2%) being electrical. The response rate to the survey (23%) was roughly the same for all eight professional societies except for the chemical engineers treated as a pilot group as previously discussed. The average age of survey respondents is 40, and the average respondent has about 16 years professional experience, although he has been employed with his present employer for the past nine years. Nearly half of all respondents are U.S. government employees with civilians outnumbering military two to one. The primary work activity of respondents is quite varied with the largest single group (35.0%) in management. Nevertheless, 77.1% of the respondents classify their present employment as engineering. On the average, the respondents appear to have impressive credentials. A large minority (37.2%) hold professional registration, and the percentages with masters and doctorate degrees (usually in engineering) is quite high, 50.9% and 14.3%, respectively. Moreover, an additional 11.1% are presently working towards a degree with the most common choices being: a masters in enginering (35.0%), a masters in business (24.3%), and a doctorate in engineering (13.2%). Given the high percentage of respondents with advanced degrees, it is not surprising that most (62.4%) say that "further academic degrees are of little importance". Nevertheless, the majority of respondents continue to be very interested in continuing education based on the percentages of individuals who have attended various activities during the past two years, including college credit courses, short courses, and employer-sponsored courses.

Few of the respondents (3.9%) reside in Washington D.C. itself with the rest fairly evenly distributed between Maryland (50.2%) and Virginia (45.0%). A more detailed view of the geographical distribution of respondents place of residence is provided by their home (x,y) coordinates, as may be seen from the map on page B1. In addition we have examined the distribution of respondents according to three-digit zip codes (page A12). The advantages of using zip codes is that this allows us to examine the survey response rate according to zip code.

From the map on page B2, it may be seen that there is no pronounced pattern to the response rate as a function of zip code position on the map[1]. For instance, there is no significant decrease in response rate as a function of distance from George Mason University. (Although, there is an enhanced response in the county in which GMU is located.) This is an important indicator of a lack of large geographical bias in the survey. As might be expected, the geographic distribution in respondents' place of business differs greatly from the distribution of their residences (see map on page B3). Although the bulk of respondents work in Washington D.C., there also appear to be some large concentrations in suburban Maryland and Virginia.

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[1] The fact that the response rate according to zip code is almost eveywhere less than the overall response rate (23%) is due to the fact that around 20% responded anonymously.

Parenthetically, we note that the validity of all geographic distributions of respondents shown in this report depends on how well individual respondents have been able to specify the (x,y) coordinates of their home and place of business using the map provided in the survey booklet. One indicator of the small error in (x,y) coordinates is given by the distribution of all respondens claiming Virginia as their place of residence. As may be seen from the map on page B4, few respondents need further continuing education on the subject of how to read maps.

There are a number of additional questions that might have been included in the survey to give further information on the statistical characteristics of respondents including: sex, race, salary, and level of responsibility (number of people supervised). However, it was felt that the inclusion of items such as these might negatively affect the response rate, and would not add a great deal of information to what is well known on a national basis:

(a) engineers include among their number very few females and blacks and other minorities.

(b) engineering pays reasonable well, with pay levels significantly correlated with level of responsibility, and with the amount of continuing education pursued.[1]

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[1] See for example the 1974 study by John Klus and Judy Jones, "Engineers Involved in Continuing Education", published by the American Society for Engineering Education.

4. Respondents Views on Engineering Education

One issue of some considerable interest among engineers concerns professional engineering schools and the practice-oriented professional school model. A question was included on this topic as relevant to engineers' views of the effectiveness of current engineering education. Since the notion of the "professional school model" may mean diferent things to different people, the exact wording of the question on professional schools could well have a significant effect on the response. For this reason several individuals were consulted on the appropriate wording. Mr. Louis Guy and other members of the Virginia Society of Professional Engineers were particularly helpful.

The responses to this question are indicated on pages A15-A16. As may be seen, a large majority of the engineers surveyed (67.9%) believe that either "some" change (47.8%) or a "great" change (20.1%) is needed toward the practice-oriented professional school model. All categories of engineers appear to have large majorities which share this belief. The category most strongly in favor is the group of engineers with twenty or more years profesional experience, 86.6% of whom believe a change toward the professional-school model is needed. It may seem somewhat surprising that the next group most in favor of a change toward a profesional-school model are those engineers now seeking a degree (73.0% for change). Thus, the two groups most strongly favoring this proposed change are those with a good fraction of their professional career behind them, and those (mostly younger engineers) still experiencing the joys (and sorrows) of academic life.

By way of contrast only 44.9% of physicists favor a change towards the professional school model. This figure, taken from the parallel survey of physicists is as expected much below that for engineers. Nevertheless, it is interesting that nearly half of the physicists, most of who are much more research-oriented than engineers, favor a change towards a professional school model, even though this issue has not been discussed at all in the physics community.

The survey also included questions on respondent's views on the effectiveness of various forms of continuing education, (see pages A17-A20). For each item, percentages are listed both including and excluding those who have "no experience on which to judge." Among those respondents with experience in each type of continuing education, college credit courses applied towards a science or engineering degree are rated as being most effective. All the other categories listed are also generally rated as being effective with roughly equal percentages in each case: employer-sponsored short courses, professional society short courses, college credit courses not applied towards a degree, college non-credit courses, and short courses sponsored by another agency. The largest percentage of respondents cited "no experience on which to judge" for short courses sponsored by "another agency" (69.5%), and the smallest percentage of respondents cited no experience on which to judge for employer-sponsored short courses (30.3%).

Considering only courses offered by colleges and universities for credit (see page A18) there appears to be a strong preference for on-campus programs provided by local colleges and universities over those provided by either extension centers of in-state universities or by out-of-state universities. These comparisons are probably most meaningful when comparing only those not citing "no experience on which to judge". Among those with experience, the preference for local campus universities even exceeds that for live programs provided at their place of employment.

The type of program considered least effective (among those with experience) is the televised or video-taped program provided at the place of employment, although a large percentage (85.4%) cite no experience on which to judge here. The relatively low rating of this type of instruction is a clear indication that respondents place a higher value on program quality than on their own convenience. Moreover, the fact that live programs at the place of employment are rated highly (second only to on-campus programs of local universities) clearly indicates that it is the non-live character of video-taped instruction which causes respondents to rate it as being relatively ineffective.

Respondents were also asked to rate the effectiveness of non-credit continuing education activities (including self-study courses). Their relative preferences ranged from short courses (most effective) to live video without "talk-back" capability (least effective). Live video with "talk-back" capability was judged to be considerably more effective (behind only short courses and seminars/symposia). Thus, it appears the interactive capability present in "talk-back" video is an essential ingredient in making video instruction effective. One should, however, be quite cautious in making comparisons among types of instruction in which the "no experience on which to judge" response varies as widely as it does here: Seminars and symposia (19.9%) to live video with "talk-back" capability (79.0%)

One way to increase the effectiveness of continuing education offerings for engineers is to eliminate those factors that act as barriers. Respondents were asked to indicate the relative importance of a number of barriers to their seeking continuing education in the past (see page A20). In view of the competing demands on time, it is not surprising that the leading barrier cited is "lack of time". After this the three barriers: "inconvenient location", "inconvenient time" and "course not available" all appear to be very important. Each of these obstacles points to a perceived deficiency in continuing engineering education by respondents who apparently want more of it, and want it offered at better locations and more convenient times.

5. Respondents' Needs for Graduate Education

As indicated previously, a sizable minority of respondents consider further degrees somewhat important (26.6%) or very important (11.0%). In fact, 27.0% of the respondents indicate that they plan to work towards a degree in the future. As displayed on page A21, this percentage is highest among Virginia residents (36.4%). At first sight this may appear to be a discrepancy in the figures: The percentages for Washington (30.3%) Maryland (30.0%), and Virginia (36.4%) are each higher than the percentage for all engineers. The reason is simply that engineers who declined to provide their names and addresses were more likely to answer the question on their need for further degrees in the negative than those that did provide them.

The specific plans for further degrees (page A21) are similar to the degrees sought by those engineers who are now seeking a degree, with the degree programs of greatest interest being masters-level engineering or business, and doctoral-level engineering.

The respondents' answers to a question on their willingness to relocate in order to pursue further education (page A22) are not surprising. Even if financial aid were available, the large majority (74.1%) indicate that relocation is not viable.

There was very little difference in the answers to this question for respondents residing in each of the three metropolitan jurisdictons. However, a question for which the differences between the three jurisdictions is somewhat significant concerns the existence of a univeristy within commuting distance that offers the program sought. The results for all respondents and for those residing in each jurisdiction appear on page A23. Based on these responses and those to a previous question (page A21) it is clear that while engineers residing in Virginia desire to pursue further degrees in somewhat greater numbers than those in other areas, the availability of universities which offer the programs they need and which are also in commuting distance is somewhat less. As gasoline prices continue to climb, it is clear that the number of miles meant by "reasonable commuting distance" will continue to shrink, thereby causing the disparity noted above to widen further.

The question of the geographic distribution of the need for graduate education (and its availability) goes beyond a simple breakdown according to the three jurisdictions since: (1)the need (and availability) may show significant variations within each of the three jurisdictions, and (2)the need may be very different for different kinds of education. We will address this important question at the end of a subsequent section after discussing the "CEXY" method: Continuing Education in x,y coordinates.

6. Needs for Non-Degree Education (Overview)

Given that the largest volume of continuing enginering education is not for the purpose of pursuing a degree; the needs for non-degree engineering education are in some respects the most important. For example, although only 27.0% of respondents indicated that they plan to pursue work towards another degree, 77.9% indicated that there were one or more specific topics for which they had a specific educational need. (The topics specified were selected from a list of 310 technical and non-technical topics listed in the questionnaire.) In every category of employed enginers large majorities cited a need for one or more specific topics (see page A24). Continuing education is clearly wanted not just by the younger engineer; even of those with 20 or more years professional experience, 68.9% cited a need for one or more topics. Only among retired engineers did less than a majority (31.9%) cite a need for specific continuing education topics.

For each specific topic requested, respondents were asked to indicate their preferences on educational supplier, format, and other matters. Before examining responses for specific topics, an interesting overview may be obtained by examining responses for all requested topics combined. For example, on page A25, we see that a college is the preferred supplier for most respondents (67.8%). However a much smaller percentage (39.6%) indicate they actually want a course for credit. As indicated on page A26, the preferences for a college as supplier and a credit course as the format are somewhat higher among Virginia residents, 75.1% and 46.4% respectively. This observation correlates with that made previously concerning the percentage of respondents intending to pursue further degrees in Virginia, Maryland, and Washington.

There are various ways to determine the magnitude of the need for a particular topic besides finding how many respondents request that topic. If we are concerned about how well the need is actually being met useful information can be obtained by asking respondents about the present status of that topic, e.g., whether it is in fact being offered in the area. Considering all topics combined (see page A27), just under half of all respondents are unaware of the present status of topics, while roughly equal percentages of the remaining half say the topic is "not offered at all," "offered but not enough to satisfy demand," or "offered enough to satisfy demand." As we shall see later, there are meaningful correlations with such responses and particular requested topics.

One measure of the persistence of various needs is how long a time respondents have had a need for a particular topic. The distribution for all topics combined appears on page A27. Whether a need is long-lasting or recent undoubtedly may depend on the respondent's particular situation, e.g., length of time in present job, or alternatively how much of a procrastinator he is. Nevertheless, as we shall later see, there tend to be significant variations with particular topics. Respondents were also asked how long they expect to continue to have this need in the future (see page A28). This was probably a poor question. Given the inability of any of us to predict much about the future, particularly when a need will no longer be present, it is not surprising that the overwhelming majority (80.3%) indicated "the foreseeable future," rather than indicating a definite time period.

A very important point relating to the availability of continuing education concerns the location of offerings. As already seen (page A20), poor location can be a serious obstacle to persons seeking a particular offering. For this reason respondents were asked to specify how far (in miles) from home and place of business they would be willing to travel before the probability of their attending a particular offering drops to 50%. The results for all topics combined are given on page A28. The distributions for the commuting distances to work and home are quite similar except that there is a definite excess in the 0-4 miles interval for the work-distance distribution. This excess is due to people who gave zero for the work-distance (indicating they would not commute from work, but would take a course offered at their place of business). Although there does appear to be a double maximum in both distance distributions, we see that on the average respondents claim to be willing to travel about 18 miles from home or work before the probability of their attending drops to 50%. (This information will be made use of in a much more precise way later.)

"Lack of time" and "poor location" were previously cited as very significant obstacles in pursuing continuing education. It is therefore not too surprising that a large majority of respondents indicate that courses offered at their place of business would be extremely or moderately advantageous (71.2%). Nevertheless, it is interesting to recall that courses for credit offered on-campus were rated as being more effective than live courses offered at respondents' place of business (counting only those having experience with either--see page A18).

Respondents' preferences on time of offering for all topics combined are tabulated on page A29. There is a very clear preference for early evening courses, as against day or weekend courses. However, this particular question is probably inapplicable to short courses or other forms of highly concentrated study.

7. Needs for Non-Degree Education (Specifics)

Of the 310 topics listed in the questionnaire every topic was requested by some respondents, but some topics were requested much more frequently than others. On page A30 we have listed the 27 topics requested most frequently with the number of requests for each. With electrical engineers the largest single group, it is not surprising that electrical engineering (including computer engineering) topics figure prominently on this list. Nevertheless, this list also includes topics from many other engineering areas, and areas outside of engineering as well. To determine what offerings are most needed we must examine not only the specific topics but respondent's preferences on supplier and format for each topic (page A31). As can be seen, while there is a definite preference for a college to be the supplier, the strength of this preference varies significantly with the particular topic. The preference for a college as the supplier does not necessarily mean that a credit course is the desired format. As may be seen on page A32, there are a number of topics for which a non-credit course or short course is favored.

Besides examining what the specific needs are, it is very relevant to examine how well these needs are currently being met. Any supplier of continuing education will surely wish to know not only how many people want a particular topic, but how well the need for that topic is already met. One measure of this is the perception of respondents concerning the present status of the topic. On page A33 we have tabulated for each of the 27 topics the percentage of respondents who assert that the topic is either not now offered or not enough to satisfy the demand. (It may be recalled that just under half of all respondents cite the topic availability as being unknown to them for all topics combined.) Thus, for some of the topics having the highest "status" (lowest availability) on page A33, nearly all those not citing the availability as unknown must have identified the topic as either not being offered or not enough to satisfy demand. The range in perceived availability of topics based on this table is quite dramatic, and an important indicator of what topics are most needed.

Another measure of the need for various topics is provided by the length of time respondents indicate they have had this need. This varies widely according to topic as indicated on page A34. If a topic has been needed for a long time, e.g. water resource systems, this may indicate that there exists a need that has not been met for some time. It may therefore be no accident that some topics such as water resource systems appear high on both lists on pages A33 and A34. However, there also appear to be topics very high on the A33 list (low availability). but very low on the A34 list (recent need) e.g., electro-optics, and radar systems. There are two plausible explanations: topics relating to new and emerging technologies will create rapidly developing educational needs (electro-optics), whereas external political, international, economic, or environmental factors-such as an increased emphasis on defense-may also create rapidly developing needs (radar systems). In either case, the need though recent is also largely unfilled, since the magnitude of its increase may not yet have been perceived by educational suppliers.

As one measure of how urgently respondents view their need for a particular topic we may consider how far they are willing to travel for various topics. On page A35 we have tabulated the percentage of respondents willing to travel 20 miles or more (before the probability of their attending drops to 50%). There is some significant variation here (though not as much as in previous tables). It is probably significant that some topics high on this list, e.g. water resource systems, are also high on the list on page A33, and are therefore relatively unavailable in the area. However, a word of caution in making such a connection is in order. The topic first on the list on page A35 (Computer Graphics) was also the topic last on page A32. Thus, the reason respondents might be willing to travel further for such a topic is that they have in mind strictly the one-time trip associated with the short course format, not the once or twice a week commute associated with taking most credit courses.

Another point of some interest concerns the question of what categories of respondents most strongly need particular topics. On page A36, we have tabulated the percentage of persons with less than 15 years experience who have requested each topic. There are very significant differences concerning which topics are needed mostly by relatively senior and junior engineers. It is not surprising to find management and public policy sorts of topics at the bottom of page A36 (few respondents with less than 15 years experience) and highly technical topics at the top. It may however be somewhat surprising to find a topic such as report writing and presentation at the top of the list (more needed by younger engineers). This may very well point to one deficiency in the current undergraduate education of engineers perceived by those advocating the professional school model. In fact it may point to an even greater deficiency in modern education generally, the lack of emphasis on writing skills.

Another classification of respondents is based on their current employer. As may be seen on page A37, the percentage of respondents who work for the federal government employees tend to have a greater interest in public policy and management sorts of topics. It is probable that this results from two factors: (1)public policy is the business of government, and (2)these "softer" topics tend to be of greater interest to older, more established engineers frequently in management positions, and the average age of government-employed engineers is greater than others.

One final classification of respondents we have examined is based on their place of residence. In the most simple classification, we may examine in which of the three metropolitan jurisdictions they reside. On page A38 we show the percentage of respondents interested in each topic citing Virginia as their place of residence. (We do not show Maryland and Washington as well, since the number of Washington respondents is in most cases too small to give a statistically meaningful result. The percentages for Maryland therefore are approximately 100% minus the percentages for Virginia.)

It is unnecessary to examine the need for all 310 topics in the questionnaire to the same degree of detail as those 27 topics in greatest demand. Nevertheless, it is useful to examine some of the measures of need for all topics. Among the two most important quantities are the magnitude of the need (how many have requested the topic) and the degree to which the need is now being met (the percentage of respondents who claim the course is either not now offered or not offered enough to satisfy the demand). These two numbers are listed for all 310 topics on pages A39-A52 where all topics have been listed according to the categories under which they appeared in the actual questionnaire. Several points should be noted about these listings:

1. Respondents had the opportunity to cite a need for a general topic e.g. electrical engineering, and these general needs are listed as well.
2. Some topics e.g. computer systems design, or electro-optics appear under more than one heading. Computer systems design appears under electrical and computer engineering. Electro-optics appears under electrical engineering and physics. While these topics are clearly in high demand (having made the top 27 list), we have actually underestimated the actual demand by not combining the numbers for the separate listings.
3. The percentages listed under "status" tend to become statistically meaningless for small numbers of persons requesting particular topics.

8. CEXY: Methodology and Results

The "CEXY" method (Continuing Education in x,y coordinates) is a mathematical model to determine the magnitude of the need for specific kinds of continuing education as a function of position on a map. The model requires as input the following six quantities: the x and y coordinates of a respondents' home, the x and y coordinates of his place of work, and the distances from home and work (d_h and d_w) the respondent indicates a willingness to travel before the probability of attending for a particular topic drops to 50%. For the majority of respondents d_h and d_w are either identical or quite close, so we shall be making use of their average value, d. For a given respondent we define a "need function", f(x,y), which yields at each point on a map the relative likelihood of the respondents attending a course if it were offered at that point. By definition we let the need function have the value 1.0 at a respondent's home or work location. We further assume the need function to satisfy the following properties (see page B5 for graphical interpretation).

1. It has the value 1.0 at all points on the line joining the home and work locations.
2. It has the value 0.5 at a distance d from the home and work locations outside the line segment connecting home and work.
3. It has a small constant value at all points on a circle of large radius centered on a point midway between home and work.

The first property is based on the assumption that a respondent is very likely to attend a course if it is offered at some point directly on the line joining home and work. The second property follows from the definition of d_h and d_w, as well as the assumption that they are usually the same. The third property follows from the reasonable assumption that the probability of attendance decreases according to distance, and that at large distances (compared to the home-work separation) the distance is virtually the same whether it is measured from home or work. One of the simplest mathematical functions which satisfies properties 1,2 and 3 is:

$$f(x,y) = e^{-z^2}$$

$$\text{where: } z = \frac{1}{2d}(d_1 + d_2 - D)\sqrt{\ln 2},$$

and: d_1=distance from (x,y) to home,
d_2=distance from (x,y) to work,
D=distance from home to work

There is one additional assumption which we must make before applying the CEXY method. Respondents were asked in the survey to specify the distance (presumably driving distance) they would be willing to travel. In applying the CEXY method using an actual map, we are working with straight line distances. Therefore, what is needed is a conversion factor between straight line distance and driving distance between any two points. While this clearly will vary from point to point, we have assumed a conversion factor of 1.5 driving miles per straight line mile. This assumption is probably the poorest of all in the model, since it fails to take into account the specific road network that exists in an area. However, to account for this in a quantitative way is difficult and probably unnecessary. While this assumption may introduce a significant distortion in the need function for one individual, its effect on the Cummulative need function for many individuals should be considerably less in view of the averaging that takes place.

On page B6 we illustrate for a typical respondent a set of contours for different values of his need function f(x,y). By combining numerically the need functions for all respondents having a particular need we obtain a cumulative need function. This has been done for each of the 27 continuing education topics which are in highest demand (see maps on pages B7-B11 for five of the 27.) To find the approximate value of a given need function at a particular point on the map one can simply interpolate between the values for a pair of contours. Note that in every case the need functions have been renormalized to have the value 1.00 at their maximum. The number of respondents who would be willing to travel to a given location can be found from the interpolated value of the need function at that location multiplied by the number N given on each map.

Having proposed a mathematical model to exhibit variations in needs as a function of position on a map, we may inquire further into its significance. The need function certainly cannot be used to predict how many persons would be likely to take a course offered at a particular location. There are simply too many variables left out, including for example: the reputation of the institution, the publicity given the course, the existence of other nearby institutions which may be offering the same course, the fact that some persons want a short non-credit course, or the fact that the institution is near work not home and some individual prefers to take a course in the evening after going home.

The need function cannot describe another important matter: how unmet needs vary with position. While the need function may be twice as great at point A than point B, the need may be fully satisfied at A and not B (or the reverse). A final complication concerns the fact that the Washington Metropolitan Area consists of three distinct political jurisdictions. Area institutions supported by public funds are generally regarded to have the primary purpose of filling the educational needs of persons who reside in their jurisdictions. Thus, for example, those respective educational planning boards for Virginia, Maryland or Washington would presumably be primarily concerned with the distribution of needs of residents of only one of the three localities. This is not to advance the provincial view that existing public educational facilities should serve only residents of their jurisdiction. Rather, the point is that when new resources may be added to expand the public educational offerings in a jurisdiction, educational planners might be expected to be most concerned with the distribution of needs for residents of their jurisdiction. With this in mind, we show one pages B12-B14 the three need function distributions for all requested topics combined for Virginia residents (page B12), Maryland residents (page B13), and Washington D.C. residents (page B14).

Despite all the defects and complications associated with the need function, we believe that it does describe how needs of various kinds vary with position on a map.

9. Course Enrollment Estimates Based on Survey

We have noted in the previous section that it would appear hazardous to use the "need function" to determine how many persons are likely to take a course offered at a given point on the map. Here we shall examine whether any connection can be made between demand indications from the survey and actual course enrollments to be anticipated for particular topics. We recognize at least two factors which would appear to make any such connection quite tenuous:

(1) Only a fraction (f_1) of those persons having a need for a particular topic were included in the survey.

(2) Only a fraction (f_2) of those persons who indicated a need will actually enroll in a given course.

Thus, if there were N people in the survey who indicated a particular need, the actual number who would enroll in a course is Nx (f_1/f_2). If we compare actual course enrollments for a given topic with the number of people who requested that topic in the survey we can empirically determine the ratio f_2/f_1 for that topic.

Let us, for example, consider the topic "Microprocessor Systems Design" requested by 332 persons in the survey (the second highest demand of all topics). For this particular topic 32% of those surveyed wanted a credit course (see page A32). Thus, the survey indicates that approximately 106 respondents want a credit course in microprocessors. (Presumably most want a course for graduate not undergraduate credit.) Inquiries to various area universities have identified six which have very recently offered a course at the graduate level in Microprocessors. These are listed on page A53. The total enrollment of the six courses combined is 101 persons. From this we conclude that the factor f_2/f_1 by which the survey number (106) must be multiplied to obtain an actual enrollment, in remarkably close to 1.0. In other words, the survey number would in this case have been an excellent predictor of the actual enrollment at area universities.

Is it possible that for topics other than microprocessors we can also estimate enrollments simply using the survey numbers? To the extent that the engineers surveyed are representative of the whole population interested in various topics, the answer would appear to be yes--at least for obtaining approximate estimates. Even if the sample were not representative the survey might still predict relative enrollments for topics in a given category. For example, even if it were true that electrical engineers were over-represented in the survey (which does not appear to be the case), an electrical engineering topic twice as much in demand in the survey as another might be expected to be twice as much in demand among electrical engineers generally.

Even though we believe that the survey numbers can give estimates of approximate enrollments we recognize that the above example ignores many factors. For example, the topic examined i.e. Microprocessor Systems Analysis, is a releatively recent need for many engineers (see page A34). In addition, it is only recently that area universities have been offering courses in this subject (see page A53). Both of these factors may make the results found for this topic not directly applicable to others. Finally, it will be noted that in comparing demand for a mircoprocessor course from the survey with course enrollments, the comparison was with the total enrollment of all area universities. It would be hazardous to try to estimate the likely enrollment at any one university using the survey numbers.

Nevertheless, an interesting correlation may be noted when enrollments of "nearby" universities (closer together than 5 miles) are combined:

	enrollment
Catholic, George Washington, Howard	46
George Mason	20
University of Maryland	20
Virginia Tech (Dulles Airport Center)	15

It is quite possibly no accident that this sequence is correlated with the relative demand expressed by the need function at each of the four locations (see page B7). The correlation is not a perfect one since the need function in Washington D.C. is not more than twice as great as that at the locations of George Mason or the University of Maryland. However, it was probably not correct to simply add the three Washington D.C. University enrollments together. These three schools are not so close together so that they are necessarily competing for the same clientele in all cases.

10. Written Comments of Survey Respondents

Space does not permit the inclusion of over 700 written comments (some quite lengthy) of respondents. In this section we shall briefly consider the gist of many of the comments which have been grouped into various categories.

A number of engineers strongly endorsed the value of continuing education, some noting that the particular subject studied is less important than keeping active and studying. Even though in some cases "getting-up to speed" after a number of years of non-academic life was considered painful it was also very rewarding in the view of one engineer. Another while strongly supporting continuing education recognized the "burnout" phenomena that sets in after around age 50 when the need and desire for more job-related education seems to decrease rapidly. (This phenomena was not particularly apparent in this survey since a sizable fraction of respondents with 20 or more years experience did indicate a need for one or more topics.) The value of continuing education was strongly attested to by a number of retired engineers who may no longer have a need for it themselves. In the words of one retired engineer:

> "I am convinced that CE is far more important than many engineers recognize, and that too many of them plod away at mediocre levels of performance without even understanding they're technologically obsolete in just a few years--and they never figure out why the best assignments start going to younger men with less experience, but with a more recent education."

On the other side, one engineer was rather dubious of continuing education. He felt that the whole field had become a "racket," and that providers of continuing education were primarily motivated by their own financial gain--this allegedly being the primary push for the movement to require engineers to obtain continuing education for professional registration.

A large number of engineers wrote about the need for various topics in continuing education to meet the needs of various specific groups. Unfortunately, some of these topics were not included in the list of 310 in the questionnaire. A partial list of topics requested includes:

(a) Building construction and maintenance

(b) Military and space-related topics

(c) Law, regulation, and public policy

(d) Review/refresher engineering courses.

(e) Courses giving an overview of new technologies

(f) Practical computer science courses.

(g) Engineering management.

Based on the number of written requests for some of these topics the demand would appear sizable. A number of engineers requesting (f) wrote at some length about the enormous gap between many college-level computer science courses and the practical courses that are actually needed by working engineers. Those who suggested topic (e) noted that this would be particularly valuable for the large number of engineers now doing adminisrative work. In their view too often continuing education is devoted to highly technical short courses. The omission of topic (g) from the list of 310 topics in the questionnaire is especially unfortunate, as this topic was written about more often than any other.

A number of engineers wrote about the relative merits of variou forms of continuing education. A significant number noted the value of self-study. In the words of one:

> "As a self-employed engineer, I have neither the time nor the money to spend on taking a course to gain specific technical knowledge. If I need it I can read a textbook or listen to a tape on it. A good theoretical background allows me to do this."

> "And of another: "...I suggest that an ideal way to develop a continuing education program for a thin and specialized market (which is characteristic of continuing education) is to develop video cassettes, complete with textbooks and homework. ...and each individual can pursue the courses at his own pace."

The use of technology, particularly home video, computers and media, was suggested by a number of engineers both in the context of self-study and other kinds of instruction.

It is worth recalling however that despite these uniformly positive written comments about self-study, video-based and computer-based instruction, these forms of continuing education were not rated as being especially effective in the survey (with the exception of live video with "talk-back" capability). Apparently, the proponents of these forms of education are most motivated to make written comments about them.

A number of engineers wrote about the pros and cons of short courses vs. courses for credits. The comments varied widely with the following being representative of two contrasting views:

> "The college courses offered for graduate credit have been severely lacking, in my opinion in meeting the needs of industrial professionals. The college credit courses have also

> been at least five years behind the needs of industry."

and:

> "My interest is biased towards college credit programs...Many of these short courses attempt to cram several semesters of material into a few days, and only end up providing a "managers survey" of the material. The price of these courses are very high compared to college courses also."

The subject of the high cost of continuing education (particularly of short courses) was probably mentioned more often than any other topic. The following comments are typical of the many engineers some of whom objected quite vehemently to these costs:

> "I would not attend nor approve employee attendance to any short course costing more than $300."

> "As it is now only the rich, the higher management class, and government employees can really afford to attend these seminars."

> "Engineering short courses sponsored by such universities as ( ) are extravagant--typically $495 to $695. They are able to do this because corporations are willing to pay the fee."

> "Unless one's employer sponsors the program, the door to continuing education is closed to the average family man."

We earlier found (in section 4) that "insufficient employer financial support" was not cited as being among the most significant obstacles to continuing education. On the surface this seems to conflict with the very large number of comments about high costs and insufficient employer support. There is, however, no conflict: for that group of engineers lacking possibile employer support, cost is a very major obstacle; for the others it is not. Other major obstacles, e.g. "lack of time," affect everyone, so that when averages are made over all respondents "insufficient employer support" will therefore not rank among the greatest obstacles.

Many other obstacles to continuing education were also discussed by a number of engineers particularly the unavailability of courses in the area, the difficulty of working out a schedule that fits in with a full-time job, and the great distance one has to travel to attend many courses. In view of this last obstacle, it is not surprising that many wrote about the great value of offering programs at the place of employment. Two additional obstacles were mentioned by a number of respondents: (1)The lack of good publicity on what is offered at all area instituions in engineering--possibly solved by some agency acting as a clearinghouse, and (2)Unnecessary red tape at many universities. Some complaints about red tape concerned complicated registration procedures, unnecessary course or degree program prerequisites, and difficulties in getting courses accepted for transfer credit.

One final obstacle to better continuing education is the quality of instruction. A number of engineers stressed the importance of having graduate engineering faculty with considerable practical experience. A number felt that this is also of great importance for undergraduate engineering education as well. Many suggestions on the undergraduate curriculum were proposed, many being highly supportive of the professional school model. Among the specific suggestions were: more cooperative education; and courses in business law, ethics, and human relations. One engineer supporting a kind of change other than the professional school model noted:

> "We should stop the general degradation in quality that has occurred over the last decade. Engineering students seem to be able to take junk courses (especially in computer fields) rather than being taught fundamentals. Industry expects to train engineers in real world practice, etc., but needs a solid honest foundation on which to build. More and more recent graduates seem to be trained by rote and can't adapt to new things".

A large number of respondents commented about particular area universities. These particular comments were more negative than positive and are not appropriate to cite here.

Finally, a significant number of engineers offered comments about the survey booklet itself. The most common criticism related to particular omissions, especially the relatively small number of non-technical topics among the 310 listed topics (and particularly engineering management). Several persons were concerned that the code number appearing on each survey booklet compromised anonymity and represented an invasion of privacy. (The code numbers were used solely to determine response rates accoding to zip code and engineering society affiliation, not to identify individuals) Despite these (and other) criticisms, there were of course many others who said very positive things about the survey.

11. Analysis of Organization Survey

Some 145 Washington D.C. metropolitan area organizations which collectively employ over ten thousand area engineers and scientists responded to the survey of organizations. In this section we shall briefly discuss some of the findings of this survey which are presented in detailed tabular form on pages A54-A66. Although the number of organizations responding was reasonably sizable, we believe the organization survey to of secondary importance compared to the individual survey. The reasons for this belief are as follows:

1. The number of engineers and scientists employed by these organizations varies extremely widely. While half employ 25 or fewer, there are 6 percent who employ 500 or more. It does not make for a particularly meaningful result to give a statistical breakdown of responses when combining organizations of such differing sizes. Moreover, the total number of organizations is not large enough to examine responses for different size categories.
2. Many of the questions on the organization survey concerned educational needs in science and engineering. It is possible that some responses might have differed if science and engineering were not lumped together.
3. It is not clear how to determine the response rate for the organization survey. Private organizations which were mailed surveys were selected on the basis of their SIC product codes is explained in section 2. A broad choice of SIC codes was used rather than a narrow one, so as to avoid missing any companies likely to employ engineers.

> As a result many companies were included which in fact do not employ engineers and have no interest in the subject of the survey. In addition, a spot check of the mailing lavels supplied by Dun's Marketing Services revealed that certain organizations which should have appeared in fact did not. Unfortunately, repeated inquiries to Dun to give an explanation for the omissions or a corrected set of labels went unanswered.

Despite these problems we believe the organization survey results to have significance (though not as great as the individual survey).

Fully half of those organizations responding to the survey identified themselves as consulting firms, and seven percent identified themselves as government agencies. The bulk of the remainder were private industries or businesses. Engineering/science R & D was identified as the primary activity of 59% of the organizations.

Continuing education for the professional staff of the organizations was identified as being of considerable importance, 43% viewing it as being "very" important, and 39% viewing it as being "moderately" important. Only for a small percentage of the organizations was the bulk of their continuing education needs met by in-house company-sponsored programs. In fact, for two-thirds of the organizations 0-25% of their professional staff's needs were met by such programs. One measure of organizational support for the continuing education of professional staff is the degree to which the organization is willing to support it financially. This varies with the nature of the expense (tuition, books, travel) and also with the nature of the program (degree program, non-degree, non-credit), as indicated on page

A57. The category of greatest support was for tuition--particularly for credit courses for which 40% of the organizations pay the full cost and 60% pay at least half. Released time for such studies was relatively rare, and granted by only 11-24% depending on the nature of the activity.

As may be expected, a sizable majority of respondents (86%) have not had the experience of a university offering any programs on their site, either live or televised, during the past two years, although a number of organizations indicated an interest in exploring the possiblility (24%).

Ratings of the effectiveness of various forms of continuing education were somewhat similar to those from the individual survey, with the largest percentages of respondents rating college credit courses applied toward a degree as being the most effective. Interestingly, college credit courses not being applied towards a degree were considered least effective (see page A59). On the question of the effectiveness of programs offered by various types of universities, respondents rankings agreed with those from the individual survey: local colleges were clearly preferred over extension campuses of in-state and out-of-state universities (ranked in that order--see page A60). Not enough respondents had experience with universities offering live or TV on-site programs to make statistically meaningful comparisons for these categories.

The ratings of effectiveness of various non-credit program formats (page A61) again agree with the individual survey in some respects, however seminars and symposia are considered more effective than short courses by organizations, and less effective by individuals. The relative expense associated with these two types of programs may possibly be a factor here if the organization has to weigh costs and benefits. The respondents view of the effectiveness of self-study programs is somewhat negative, in agreement with the individual survey.

An examination of the relative importance of various obstacles to continuing education for the organization's professional staff produced almost the same ranking as in the individual survey (see page A62). Those obstacles rated as being the top four were also the top four in the individual survey, but in slightly different order: "staff too busy", "topic not available", "inconvenient time", "inconvenient location".

On the question relating to the practice-oriented professional school model, the result agrees reasonably well with the individual survey: a majority (61%) favor "some" change or a "great" change towards the professional school model (see page A64). As a check for possible biases in this question, the order of the responses in the organization questionnaire was changed with "no opinion" listed first. This may have resulted in a slightly higher "no opinion" response as compared to the individual survey in which "no opinion" was listed fourth.

Organizations were also asked to identify the number of scientists and engineers holding various degrees (see page A65), and also to indicate the number of persons seeking various degrees. Unfortunately, this latter information is not susceptible to a meaningful statistical presentation. (Such information is much better obtained from the individual survey.) In addition to specifying the degree-program needs of the professional staff organizations also indicated which topics the staff had need for, apart from the question of degrees or credits (see page A66 for the most frequently requested topics). Not surprisingly, many of the topics on this list also appeared on the list of those topics most frequently requested by individuals.

Number of Engineers in the Greater Washington, DC Metropolitan Area

Type	Number Surveyed[1]	Number Employed[2]	Percent Surveyed
Electrical	9276	15100	61
Civil	4059	6950	58
Mechanical	2637	5485	48
Aeronautical	2135	1880	114
Professional	1563	-	-
Naval	1485	-	-
Industrial	1284	7875(?)[3]	16(?)
Chemical	866	470(?)	184(?)

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1. Number of names supplied by each professional society for its membership in the Greater Washington DC area.
2. Numbers listed in the document: "Industrial and Occupational Employment to 1985". The figures listed above are an average of the figures given for 1974 and 1985 (projected).
3. Based on a discussion with the President of the National Capitol Chapter of AIIE, this number is almost certainly in error.

A2

Multiple Mailings for Chemical Engineers

	First Mailing	Second Mailing
Number of persons returning completed survey booklets	275	65
Percent return rate	31.8	7.5
Percent of survey booklets returned blank	21	37
Percent of completed booklets indicating a need for one or more continuing education topics	65	68
Ratio of number of Virginia and Maryland respondents	0.30	0.37

A3

0. Engineering Society

	Respondents (Percent)[1]	Return Rate (Percent)[2]
Electrical	38.2	22.1
Civil	16.8	22.2
Mechanical	11.7	23.9
Aeronautical	8.6	21.5
Naval	6.9	25.0
Professional	6.9	23.7
Chemical	6.3	39.3
Industrial	4.6	19.4

1. Percentages based on 5377 respondents

2. Percentages based on 23,305 mailed questionnaires

1. Age

	Percent
Under 20	0.0
20-24	4.1
25-34	25.2
35-44	28.1
45-54	23.0
55 and over	19.6

(Percentages based on 5357 respondents)

2. What is your current employment status?	Percent
employed full-time	92.4
employed part-time	3.2
not employed	0.6
retired	3.8

(Percentages based on 5354 respondents)

3. Which category best describes your principal employment?	Percent
engineer	77.1
administrator	10.0
computer specialist	4.2
physical scientist	2.2
mathematician or statistician	1.1
teacher (non-college)	0.8
technician or technologist	0.4
health professional	0.3
other	3.9

(Percentages based on 5234 respondents)

A5

4. How many years have you been employed with your present organization?

Years	Percent
0-4	36.0
5-9	22.2
10-14	15.9
15-19	10.1
20-24	6.4
25-29	4.5
30-34	2.8
35-39	1.2
40-44	0.5
45-49	0.1
50-54	0.1

(Percentages based on 5199 respondents)

5. How many years of professional science or engineering work experience have you had?

Years	Percent
0-4	10.5
5-9	14.7
10-14	15.8
15-19	13.2
20-24	14.2
25-29	10.6
30-34	10.8
35-39	4.7
40-44	4.0
45-49	1.0
50-54	0.5

(Percentages based on 5296 respondents)

6. Which category best describes the type of organization of your principal employment?

Employer	Percent
U. S. government (civilian)	28.9
industry or business	24.6
consulting firm	19.9
U.S. government (military)	14.6
educational institution	3.2
state or local government	2.6
self-employed	1.8
professional association	0.6
international agency	0.5
other	3.3

(Percentages based on 5334 respondents)

7. Do you hold professional registration?

	Percent
Yes, in engineering	37.2
Yes, in other field	1.6
No	61.1

(Percentages based on 5219 respondents)

8. In which one of the following activities are you most involved?

Activity	Percent
management and administration	35.0
design	12.9
consulting	11.8
applied research	9.9
development	8.9
testing/evaluation	5.6
teaching	2.2
construction	2.1
sales, marketing	1.9
basic research	1.8
production	1.5
quality control	0.5
other	5.9

(Percentages based on 5313 respondents)

9. What academic degrees have you received?

		Degree Level	
Subject	Bachelors	Masters	Doctorate
Engineering	83.1	38.1	9.8
Physical Science	5.9	3.1	1.9
Math and Comp. Sci.	2.2	2.1	0.6
Education	0.9	0.7	0.1
Business	0.7	4.5	0.5
Other	1.8	2.5	1.4
All fields	94.6	50.9	14.3

(Percentages based on 5377 respondents)

10. Are you presently working towards a degree?

	Percent
Yes	11.1
No	89.9

(Percentages based on 5343 respondents)

	Degree Level	
	Masters	Doctorate
Subject		
Engineering	35.0	13.2
Business	24.3	1.3
Mathematics and Comp. Sci.	9.7	1.3
Physical Science	2.4	0.8
Education	0.8	0.8
Other	5.4	4.6

(Percentages based on 370 respondents)

Year Degree Expected	Percent
1979	24.8
1980	25.0
1981	24.4
1982	12.0
≥1983	13.8

(Percentages based on 549 responses

23.

Mailing address	Percent
District of Columbia	3.9
Maryland	50.2
Virginia	45.0
Other	0.9

(Percentages based on 3938 respondents)

Percent respondents and percent return rates for various zip codes.

State	Zip Code	Respondents Percent[1]	Return Rate Percent[2]
DC	200	9.3	13
DC	201	.0	
DC	202	.2	
DC	203	.4	
DC	204	.1	
DC	205	.2	
MD	206	1.3	19
MD	207	8.4	16
MD	208	7.5	14
MD	209	5.6	17
MD	210	9.3	19
MD	211	3.5	17
MD	212	6.9	15
MD	213	.0	
MD	214	1.8	18
MD	215	.0	
MD	216	.2	
MD	217	.7	
MD	218	.0	
MD	219	.0	
VA	220	18.0	26
VA	221	12.6	22
VA	222	4.7	17
VA	other	9.2	17

1. Percentages based on 4154 respondents
2. Percentages based on 23305 mailed questionnaires

12. To what extent are you interested in pursuing a program leading to a particular academic degree, as opposed to simply taking courses in needed subjects?

	Percent
Further academic degrees very important	11.0
Further academic degrees somewhat important	26.6
Further academic degrees of little importance	62.4

(Percentages based on 5341 respondents)

14. For each of the following forms of continuing education how many courses in science or engineering have you participated in during the last two years?

	One	Two or More
College credit courses applied toward a graduate science or engineering (S&E) degree	3.0	15.4
College credit S&E courses not being applied toward a graduate degree	7.2	7.5
College credit S&E noncredit courses, including short courses	12.7	11.9
Professional society S&E short courses	19.8	14.8
Employer-sponsored S&E short courses or workshops	23.2	30.1
Short courses sponsored by another agency	12.3	7.2

(Percentages based on 5377 respondents)

13. To what extent should academic degree programs be changed to the professional school model? (In a professional school program lasting more than four years and leading to a professional degree there would be greater emphasis on design and professional practice, as against theory and research, and on non-technical subjects including writing, economics and ethics, as well.)

	Percent
Great change needed in emphasis toward practice-oriented professional school model	20.1
Some change needed in emphasis toward practice-oriented professional school model	47.8
No change needed	14.2
No opinion	13.0
Change is needed, but of a different kind	5.0

(Percentages based on 5210 respondents)

A16

Percentage of respondents who assert that either a great change or some change in emphasis is needed towards a practice-oriented professional school model.

Category	Percent
Engineers with 20 or more yrs. professional experience	86.6
Engineers now seeking a degree	73.0
Members of NSPE	72.5
Maryland residents	69.8
Engineers with 0 - 5 years experience	69.6
Engineers doing administration	69.0
ALL ENGINEERS	67.9
Virginia residents	67.5
Employed by U.S. government	66.8
Members of IEEE	63.1
Physicists	44.9

15. How effectively have each of the following forms of continuing education met your continuing education needs in science and engineering? (Numbers in parenthesis total 100% when "no experience" is excluded.)

	Very effectively (%)	Moderately effectively (%)	Slightly effectively (%)	Ineffectively (%)	No experience on which to judge (%)
College credit courses applied towards a graduate science or engineering degree	20.8 (42.5)	16.7 (34.2)	7.0 (14.3)	4.4 (9.0)	51.1 -
Employer-sponsored short courses and workshops (S&E)	19.1 (27.4)	31.7 (45.4)	14.4 (20.7)	4.4 (6.3)	30.3 -
Professional society short courses	12.3 (25.8)	22.0 (46.2)	10.4 (21.8)	2.9 (6.1)	52.4 -
College credit S&E courses not being applied toward a graduate degree	11.1 (27.6)	17.7 (44.0)	8.0 (19.9)	3.3 (8.2)	59.8 -
Short courses sponsored by another agency	9.1 (29.8)	12.7 (41.6)	6.4 (21.0)	2.2 (7.2)	69.5 -
College S&E non-credit courses	11.0 (24.0)	21.0 (45.9)	10.4 (22.7)	3.3 (7.2)	54.2 -

(Percentages based on 3938 respondents)

16. Considering only continuing education provided by colleges and universities for credit how would you rate the effectiveness of the following continuing education programs you have taken? (Numbers in parenthesis total 100% when "no experience" is excluded.)

	Very effective (%)	Moderately effective (%)	Slightly effective (%)	Ineffective (%)	No experience on which to judge (%)
Programs provided by local colleges and universities on their campus	18.2 (37.9)	21.6 (45.0)	6.0 (12.5)	2.1 (4.4)	52.0
Live programs provided by universities at your place of employment	9.1 (38.4)	9.5 (40.1)	3.4 (14.3)	1.7 (7.2)	76.3
Programs provided by in-state universities at an extension campus	7.6 (27.3)	13.6 (48.9)	4.6 (16.5)	1.9 (6.8)	72.2
Programs provided by out-of-state universities on an extension campus	5.0 (24.8)	9.0 (44.6)	4.1 (20.3)	2.0 (9.9)	79.8
Televised or video taped programs provided by universities at your place of employment	1.6 (11.0)	4.3 (29.5)	4.9 (33.6)	3.8 (26.0)	85.4

(Percentages based on 4477 respondents)

17. Considering only non-credit continuing education how would you rate the effectiveness of the following program formats in meeting your professional needs? (Numbers in parenthesis total 100% when "no experience" is excluded.)

	Very effective (%)	Moderately effective (%)	Slightly effective (%)	Ineffective (%)	No experience on which to judge (%)
Short courses	24.5	37.8	10.9	1.8	24.9
	(32.6)	(50.3)	(14.5)	(2.4)	-
Seminars and symposia	21.9	37.8	17.6	2.8	19.9
	(27.3)	(47.2)	(22.0)	(3.5)	-
Live video with "talk back"	3.5	8.3	5.6	3.6	79.0
	(16.7)	(39.5)	(26.7)	(17.1)	-
Self-study courses	7.6	25.6	19.5	6.4	40.8
	(12.8)	(43.2)	(33.0)	(10.8)	-
Computer-based instruction	2.5	8.5	8.4	4.4	76.2
	(10.5)	(35.7)	(35.3)	(18.5)	-
Video-taped instruction	2.9	12.0	14.5	7.9	62.7
	(7.8)	(32.2)	(38.9)	(21.1)	-
Live video w/o "talk back"	0.6	5.7	8.9	7.3	77.5
	(2.7)	(25.3)	(39.6)	(32.4)	-

(Percentages based on 4742 respondents)

18. How important have each of the following barriers been to your seeking continuing education in the past?

	Very significant barrier (%)	Moderately significant barrier (%)	Slightly significant barrier (%)	Insignificant barrier (%)
lack of time	42.2	28.6	14.8	14.1
inconvenient location	38.1	26.8	15.7	19.2
inconvenient time	37.1	26.0	18.2	18.4
course not available	35.2	18.2	15.2	31.0
course poorly presented	16.5	21.5	20.7	40.5
unaware course offered	17.2	19.7	22.2	40.5
lack of incentive	12.4	23.2	25.2	38.8
insufficient employer financial support	17.4	14.9	16.3	51.0
educational level too low	10.8	15.1	17.3	56.3
educational level too high	2.9	7.9	13.2	75.5

(Percentages based on 4447 respondents)

A21

11. Do you plan to possibly work towards a degree in the future?

	DC residents Percent	MD residents Percent	VA residents Percent	All Engineers
Yes	30.3	30.0	36.4	27.0
No	69.7	70.0	63.6	73.0

(Percentages based on 5136 responses)

	Future Degree Level	
Subject	Masters	Doctorate
Business	28.5	3.7
Engineering	25.2	20.3
Mathematics and Comp. Sci.	7.3	3.6
Physical Science	0.7	0.9
Education	0.2	0.3
Other	2.9	5.3

(Percentages based on 1814 respondents)

Year expected to start	Percent
1979	30.8
1980	34.0
1981	18.0
1982	7.5
≥1983	9.8

(Percentages based on 1027 respondents)

22. If you have indicated that you plan to work toward a degree in the future, to what extent would relocation and full time study be a viable option for you?

	Percent	VA - only
Relocation would present no serious problem.	7.3	7.7
Relocation would present some problem, but I might be willing to do it, particularly if financial aid were available.	18.7	18.9
Relocation would not be a viable option for me.	74.1	73.4

(Percentages based on 1931 respondents)

21. If you indicated that you plan to work toward a degree in the future, is there a university within a reasonable commuting distance that offers the degree you plan to seek?

	Percent
Yes	59.4
No	20.5
Don't know	20.1

(Percentages based on 1936 respondents)

21. If you indicated that you plan to work toward a degree in the future, is there a university within a reasonable commuting distance that offers the degree you plan to seek?

	DC Residents Percent	MD Residents Percent	VA Residents Percent
Yes	71.9	62.7	55.7
No	7.8	21.0	20.2
Don't know	20.3	16.3	24.1
Number of respondents	64	834	793

A24

Percentage of Respondents Indicating a Need for One or More Particular Topics

Category of Respondents	Percent
Now seeking an engineering degree	90.6
Further degrees somewhat or very important	88.7
0 - 5 years professional experience	85.6
Maryland resident	85.3
Virginia resident	84.0
IEEE Member (Electrical Engineer)	80.0
Washington, DC resident	78.6
Federal Government employee	78.1
ALL ENGINEERS	77.9
Further degrees of little importance	73.0
Doing administrative work	72.5
More than 20 years experience	68.9
Retired engineers	31.9

A25

19. Preferred supplier of continuing engineering education (all requested topics combined)

	Supplier of First Choice (Percent)	Supplier of Second Choice (Percent)
college	67.8	18.7
professional society	14.7	42.9
employer	11.8	22.0
self	3.4	13.4
other	2.3	2.9

(Percentages based on 4208 respondents)

Preferred format for continuing engineering education (all requested topics combined).

	Format of First Choice (Percent)	Format of Second Choice (Percent)
credit course	39.6	7.8
non-credit course	18.8	19.3
short course	27.2	32.1
lecture series	9.1	25.8
self-paced	5.3	15.0

(Percentages based on 4213 respondents)

A26

19. Preferred supplier of continuing engineering education among Virginia residents (all requested topics combined).

	Supplier of First Choice (Percent)	Supplier of Second Choice (Percent)
college	75.1	15.4
professional society	12.3	46.6
employer	8.2	22.5
self	2.3	13.1
other	1.9	2.4

(Percentages based on 1491 respondents)

Preferred format for continuing engineering education among Virginia residents (all requested topics combined).

	Format of First Choice (Percent)	Format of Second Choice (Percent)
credit course	46.4	7.6
non-credit course	17.0	19.6
short course	23.0	34.2
lecture series	9.0	23.7
self-paced	4.6	14.8

(Percentages based on 1492 respondents)

19. Present status for this topic (all requested topics combined).

	Percent
Not being offered at all	16.9
Offered, but not enough to satisfy demand	18.8
Offered enough to satisfy demand	16.7
Unknown	47.6

(Percentages based on 4063 respondents)

19. Persistence of need: For how many months have you had a need for this topic? (All requested topics combined.)

Months	Percent
0 - 11	20.0
12 - 23	28.0
24 - 35	18.2
36 - 47	8.0
48 - 59	5.3
60 - 71	5.9
72 - 83	0.9
84 - 95	0.4
96 or more	13.4

(Percentages based on 3485 respondents)

19. How many months do you expect to continue to have this need (all requested topics combined).

Months	Percent
0 - 11	3.4
12 - 23	6.8
24 - 35	4.4
36 - 47	1.9
48 - 59	1.4
60 - 71	1.4
72 - 83	0.4
84 - 95	0.1
Forseeable Future	80.3

(Percentages based on 3763 respondents)

19. Preferred location: How many miles from your home or business would the course have to be offered before the likelihood of your attending dropped by 50%? (All requested topics combined.)

	Percent	
Miles	Home	Work
0 - 4	1.9	11.5
5 - 9	8.9	11.1
10 - 14	28.6	27.6
15 - 19	15.8	13.2
20 - 24	20.5	16.4
25 - 29	7.8	6.4
30 - 34	8.6	6.8
35 or more	7.8	7.3

(Percentages based on 4029 respondents)

19. How advantageous would it be to have the course offered at your place of business? (All requested topics combined)

	Percent
extremely advantageous	53.8
moderately advantageous	17.4
unimportant	10.6
prefer off-site location	18.1

(Percentages based on 4095 respondents)

19. Preferred time of offering (all requested topics combined).

	Time	Percent
earlier than	4 p.m.	9.2
	4 p.m.	12.8
	5 p.m.	17.7
	6 p.m.	20.0
	7 p.m.	24.0
	8 p.m.	6.7
	9 p.m.	0.5
	weekends	5.6
	other	3.5

(Percentages based on 4104 respondents)

27 Topics in Highest Demand

"Number": The number of respondents requesting particular topics.

Topic	Number
Communication Systems	360
Microprocessor Systems Design	332
Signal Processing	246
Role and Management of Modern Technology	243
Report Writing and Presentation	236
Digital Systems	196
Technology Assessment and Public Policy	190
Software Engineering - Applications	189
Computer Systems Design	187
Data Base Management	185
Accounting	174
Advanced Programming	161
Radar Systems	156
Statistical Methods	154
Management Systems	149
Alternate Sources of Energy	144
Hydrology - Hydrosystems	134
Systems Theory and Design	129
Computer Graphics	129
Engineering and Public Policy	128
Antennas and Wave Propagation	117
Water Resource Systems	113
Solar Systems - Analysis and Design	112
Computer Languages	110
Electro-optics	106
Probabalistic Methods in Systems Engineering	105
Electric Power Systems	98

27 Topics in Highest Demand

The percentages of respondents who have requested a particular topic who give as their first choice of supplier a college, a professional society and their own employer.

Topic	Percent College	Percent Prof. Soc.	Percent employer
Systems Theory and Design	76	11	6
Accounting	73	4	13
Water Resource Systems	72	18	7
Antennas and Wave Propagation	71	13	9
Solar Systems - Analysis and Design	70	14	3
Statistical Methods	70	11	13
Computer Systems Design	69	14	12
Communication Systems	68	14	12
Computer Languages	68	7	20
Management Systems	68	14	14
Technological Assessment and Public Policy	68	13	9
Signal Processing	67	13	15
Role and Management of Modern Technology	66	18	10
Probabalistic Models in Systems Engineering	66	12	15
Engineering and Public Policy	66	23	6
Alternate Sources of Energy	65	17	7
Digital Systems	65	9	18
Electric Power Systems	64	19	7
Hydrology - Hydrosystems	62	21	12
Data Base Management	59	21	10
Electro - optics	59	22	19
Advanced Programming	58	13	19
Radar Systems	57	19	17
Software Engineering - Applications	52	20	19
Microprocessor Systems Design	50	18	22
Computer Graphics	48	18	21
Report Writing and Presentation	44	22	29

27 Topics in Highest Demand

The percentages of respondents who have requested a particular topic who give as their first choice of format a credit course, a non-credit course, and a short course.

Topic	Percent Credit Course	Percent Non-cr Course	Percent Short Course
Systems Theory and Design	50	10	24
Accounting	47	23	18
Digital Systems	45	20	22
Computer Systems Design	44	17	29
Antennas and Wave Propagation	44	22	15
Water Resource Systems	44	18	28
Probabalistic Methods in Systems Engineering	43	20	23
Electric Power Systems	41	18	29
Solar Systems - Analysis and Design	40	17	22
Management Systems	40	17	29
Communication Systems	38	25	27
Advanced Programming	38	12	27
Signal Processing	37	28	21
Role and Management of Modern Technology	35	21	26
Engineering and Public Policy	34	18	23
Software Engineering - Applications	33	20	29
Computer Languages	33	33	20
Statistical Methods	32	25	24
Alternate Sources of Energy	32	24	21
Data Base Management	32	13	38
Hydrology - Hydrosystems	32	16	41
Microprocessor Systems Design	32	21	32
Radar Systems	28	24	28
Technological Assessment and Public Policy	27	21	27
Elecrto - optics	26	38	26
Report Writing and Presentation	21	26	38
Computer Graphics	15	23	47

27 Topics in Highest Demand

"Status": Percent of Respondents who assert that the topic is either not now offered at all or not enough to satisfy the demand.

Topic	Status
Electric Power Systems	56
Electro - optics	49
Water Resource Systems	43
Hydrology - Hydrosystems	42
Radar Systems	40
Report Writing and Presentation	38
Software Engineering - Applications	37
Signal Processing	36
Communications Systems	34
Role and Management of Modern Technology	31
Antennas and Wave Propagation	31
Digital Systems	31
Technological Assessment and Public Policy	30
Statistical Methods	29
Computer Systems Design	29
Computer Graphics	28
Data Base Management	28
Microprocessor System Design	27
Advanced Programming	26
Alternate Sources of Energy	25
Engineering and Public Policy	25
Probabalistic Methods in Systems Engineering	23
Management Systems	23
Solar Systems - Analysis and Design	22
Computer Languages	19
Accounting	18
Systems Theory and Design	18

27 Topics in Highest Demand

"Percent - 2 yrs.": The percentage of respondents who assert that they have had a need for this topic for 2 years or more.

Topic	Percent - 2 yrs.
Water Resource Systems	71
Role and Management of Modern Technology	66
Engineering and Public Policy	60
Technological Assessment and Public Policy	57
Systems Theory and Design	57
Statistical Methods	56
Computer Languages	55
Hydrology - Hydrosystems	55
Report Writing and Presentation	54
Solar Systems - Analysis and Design	51
Signal Processing	51
Advanced Programming	51
Digital Systems	48
Management Systems	47
Software Engineering - Applications	46
Communication Systems	46
Computer Systems Design	46
Electric Power Systems	46
Accounting	44
Probabalistic Models in Systems Engineering	42
Antennas and Wave Propagation	40
Data Base Management	39
Microprocessor System Design	38
Alternate Sources of Energy	38
Electro - Optics	37
Radar Systems	34
Computer Graphics	31

27 Topics in Highest Demand

"Percent - 20 mi.": The percentage of respondents willing to travel 20 miles or more to take a course.

Topic	Percent - 20 mi.
Computer Graphics	56
Water Resource Systems	55
Hydrology - Hydrosystems	55
Data Base Management	50
Advanced Programming	49
Microprocessor System Design	49
Computer Systems Design	48
Engineering and Public Policy	47
Software Engineering - Applications	47
Antennas and Wave Propagation	46
Digital Systems	46
Computer Languages	45
Electro - optics	45
Radar Systems	45
Signal Processing	45
Role and Management of Modern Technology	44
Technological Assessment and Public Policy	43
Accounting	43
Alternate Sources of Energy	41
Electric Power Systems	41
Systems Theory and Design	41
Management Systems	41
Communication Systems	40
Statistical Methods	40
Report Writing and Presentation	38
Probabalistic Methods in Systems Engineering	38
Solar Systems - Analysis and Design	37

27 Topics in Highest Demand

"Percent - 15 yrs.": The percentage of respondents who have requested a particular topic who have less than 15 years professional experience.

Topic	Percent - 15 yrs.
Report Writing and Presentation	57
Signal Processing	57
Electric Power Systems	57
Antennas and Wave Propagation	56
Accounting	54
Computer Graphics	53
Hydrology - Hydrosystems	52
Data Base Management	52
Microprocessor Systems Design	52
Water Resource Systems	50
Radar Systems	50
Software Engineering - Applications	48
Communication Systems	47
Electro - optics	47
Statistical Methods	45
Digital Systems	45
Computer Systems Design	45
Advanced Programming	45
Systems Theory and Design	44
Solar Systems - Analysis and Design	44
Computer Languages	41
Alternate Energy Systems	36
Role and Management of Modern Technology	35
Technological Assessment and Public Policy	33
Engineering and Public Policy	33
Probabalistic Methods in Systems Engineering	32
Management Systems	32

27 Topics in Highest Demand

"Percent Gov't": The percentage of respondents who have requested a particular topic who are U. S. Government employees.

Topic	Percent - Gov't
Engineering and Public Policy	63
Technological Assessment and Public Policy	62
Role and Management of Modern Technology	55
Computer Graphics	47
Management Systems	47
Probabalistic Models in Systems Engineering	47
Radar Systems	46
Report Writing and Presentation	45
Alternate Sources of Energy	45
Microprocessor System Design	45
Electro-optics	45
Data Base Management	44
Antennas and Wave Propagation	43
Electric Power Systems	42
Signal Processing	41
Digital Systems	41
Computer Languages	41
Systems Theory and Design	41
Computer Systems Design	40
Software Engineering - Applications	38
Communication Systems	37
Advanced Programming	36
Water Resources Systems	32
Statistical Methods	32
Accounting	29
Solar Systems - Analysis and Design	29
Hydrology - Hydrosystems	26

27 Topics in Highest Demand

"Percent VA": The percentage of respondents who have requested a particular topic who are Virginia residents.

Topic	Percent - VA
Electric Power Systems	68
Hydrology - Hydrosystems	64
Advanced Programming	61
Software Engineering - Applications	58
Computer Graphics	58
Radar Systems	58
Alternate Sources of Energy	57
Report Writing and Presentation	55
Accounting	55
Solar Systems - Analysis and Design	55
Microprocessor Systems Design	55
Digital Systems	54
Water Resource Systems	53
Computer Systems Design	52
Signal Processing	51
Role of Management in Modern Technology	50
Electro-optics	50
Statistical Methods	49
Antennas and Wave Propagation	49
Systems Theory and Design	49
Management Systems	48
Computer Languages	48
Engineering and Public Policy	48
Technological Assessment and Public Policy	47
Probabilistic Methods in Systems Engineering	47
Communications Systems	45
Data Base Management	42

Number of respondents requesting various topics and the respondent's view of the status of these topics. "Status" is the percentage of respondents who assert that the topic is either not now offered at all or not enough to satisfy the demand.

	#	Status
Aerospace-Aeronautical Engineering	43	39
Space Communications	80	29
Digital Computer Controlled Systems	50	32
Space Systems and Control	45	44
Stability and Control of Flight Vehicles	44	64
Aerodynamics	36	33
Automatic Control of Flight Vehicles	26	58
Instrumentation Guidance and Control	22	50
Space Dynamics	19	63
Flight Transportation	16	50
Other	25	63
Agricultural Engineering	1	0
Soil and Water Conservation	26	33
Irrigation Technology	12	33
Forrestry	8	25
Field Machinery Design	6	25
Agricultural Processing Systems	3	100
Other	6	25

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	#	Status
Architectural Engineering	23	13
Architectural Design and Analysis	23	9
Building Processes	22	33
Industrial Building Design	14	33
Structural Systems, Analysis and Design	14	33
Environmental Controls	13	25
Planning for Community Facilities	12	33
Metropolitan Planning	11	16
Technology and City Planning	10	0
Urban Design and Analysis	9	20
Computer Simulation of Architectural Systems	8	25
City Design	7	50
Other	7	50
Bioengineering	23	13
Biomedical Systems Analysis	20	18
Clinical Engineering	20	50
Instrumentation	19	33
Biomechanics	18	33
Monitoring with Microcomputer Systems	16	50
Technology Application to Biosystems	16	60
Bioelectronics	13	0
Artificial Organs	12	14
Biomedical Materials	11	44
Biomedical Heat and Mass Transfer	10	0
Bioelectrical Signals	9	100
Sensory Communication	8	50
Biophysics of Neuroelectric Potential	7	50

Bioengineering (continued)	#	Status
Biological Membranes and Structural Tissue	7	25
X-ray Diagnosis	6	0
Biological Effects of Noise	5	0
Electrocardiography	4	100
Other	8	40
Chemical Engineering	24	50
Combustion and Air Pollution	28	35
Industrial Chemical Processes	28	50
Chemical Engineering Processes - Analysis and Control	27	31
Computer Simulation of Chemical Processes	22	61
Chemical Engineering Processes - Design	21	38
Polymers - Structure and Properties	21	35
Chemical Kinetics	16	37
Transport Phenomena	15	85
Chemical Calculations	12	40
Process Optimization	12	33
Chemical Thermodynamics	11	33
Petroleum	10	44
Spectroscopy	7	0
Reactor Design	5	0
Other	19	71

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	#	Status
Civil Engineering	64	39
Hydrology - Hydrosystems	134	42
Water Resource Systems	113	43
Water Resources and Control	95	38
Finite Element Method Applications	94	41
Geotechnology	91	43
Soil Mechanics - Dynamics	89	41
Transportation Systems	89	38
Structural Analysis and Design	87	28
Urban Planning	80	25
Earthquake Engineering	72	50
Traffic Systems	62	27
Design and Analysis of Concrete Structures	61	21
Highway Technology	60	34
Transportation Facilities	54	46
Design and Analysis of Steel Structures	51	28
Engineering Materials	42	23
Building Design Systems	42	41
Airport Planning and Design	39	47
Structural Systems	31	23
Structural Materials	19	16
Satellite and Physical Geodesy	15	25
Mechanics of Deformable Bodies	10	0
Other	90	64

A43

	#	Status
Computer Engineering	237	33
Software Engineering - applications	189	37
Data Base Management	185	28
Advanced Programming: Top-down design and structural programming	161	26
Management Systems	149	23
Computer Graphics	129	28
Systems Theory and Design	129	18
Computer Languages	110	19
Computer Architecture	94	32
Machine and Programming Languages	90	18
Information Processing	84	25
Numerical Methods	78	40
Computer Simulation	76	17
Systems Simulation	65	24
Operating Systems	63	34
Processing Systems - Fundamental Algorithms	44	11
Language Translation and Compiler Construction	30	35
Other	67	57

A44

	#	Status
Electrical Engineering	136	28
Communications Systems	360	34
Microprocessor System Design and Analysis	332	27
Signal Processing	246	36
Digital Systems	196	31
Computer Systems Design	187	29
Radar Systems	156	40
Antennas and Wave Propagation	117	31
Electro-optics (fiber optics)	106	49
Power Systems	98	56
Image Processing	96	40
Microwave Theory and Techniques	85	46
Electronic Devices and Circuits	83	27
Microelectronics	76	33
Control Systems	71	34
Solid State Circuits	68	35
Information Systems	68	37
Lasers	66	46
Simulation Methods for Analysis and Control	66	26
Operations Research	63	25
Electromagnetic Capability	62	42
Electronic Instrumentation and Control	61	32
Instrumentation and Measurement	56	37
Semiconductor Devices	56	37
Reliability	53	43
Feedback Control Systems	50	40

Electrical Engineering (continued)	#	Status
Pattern Recognition	45	28
Structure and Translation of Computer Languages	43	31
Sonar Systems	42	33
Electron Devices	41	50
Switching Theory and Logic Design	40	47
Artificial Intelligence	35	44
Lightning Protection	34	47
Electric Machines	33	73
Electromagnetic Theory	31	25
Industrial Electronics and Control Instrumentation	29	35
Programming Language Processors	26	50
Networks	23	20
Cybernetics	20	60
Vehicular Technology	19	20
Broadcasting	18	50
Magnetics	15	50
Image Transmission Systems	14	33
Consumer Electronics	13	50
Energy Transducers	13	66
Bioelectronics	13	33
Nuclear and Plasma Sciences	12	37
Sonics and Ultrasonics	11	50
Radio Astronomy	9	100
Other	62	45

	#	Status
Environmental Engineering	49	32
Wastewater Treatment	86	25
Environmental Impact Assessment	82	37
Sanitary Systems	41	37
Environmental Quality Control	30	50
Air Pollution Systems Analysis and Design	29	45
Air Pollution Control	27	16
Environmental Noise Control	17	44
Sanitary Control	11	33
Other	39	61
Industrial Engineering	49	38
Cost Control	86	36
Modeling, Simulation and System Simulation	69	43
Production Planning and Control	51	25
Manufacturing Processes	48	45
Stochastric Models in Operations Research	37	45
Plant Design and Layout	37	45
Industrial Systems	35	50
Quality Control	34	20
Reliability Control	31	41
Occupational Safety and Control	31	50
Process Control	19	37
Other	28	85

	#	Status
General Engineering	86	28
Role and Management of Modern Technology	243	31
Technological Assessment and Public Policy	190	30
Alternate Sources of Energy	144	25
Engineering and Public Policy	128	25
Probabalistic Models in Systems Engineering and Operations Research	105	23
Statistical Analysis	83	27
Energy and Human Affairs	80	24
Numerical Methods of Engineering Analysis	60	16
Optimization Techniques	56	10
Pollution and Environmental Impact	45	36
Random Processes	22	20
Other	62	41
Mathematics	87	32
Statistical Methods	154	29
Numerical Analysis	68	25
Stochastic Methods	56	20
Queing Theory	41	44
Linear Programming	32	22
Coding Theory	28	30
Matrix Theory	28	30
Experimental Design	28	0
Nonlinear Programming	26	25

Mathematics (continued)	#	Status
Partial Differential Equations	19	12
Ordinary Differential Equations	16	20
Graph Theory	16	50
Special Functions	10	80
Combinatorics	6	0
Mechanical Engineering	66	25
Solar Systems - Analysis and Design	112	22
Energy Conversion	74	25
Computer Modeling of Mechanical Systems	73	19
Heating - Refrigeration and A/C	71	30
Instrumentation and Control	68	50
Solar Energy Generation	64	35
Modeling and Simulation of Systems	57	48
Fluid Mechanics	57	26
Thermal Power Systems - Power Generation	55	30
Vibrations - Sound and Structural	54	44
Analysis and Design of Systems	52	25
Materials Processing and Manufacturing	51	28
Combustion Engineering	47	20
Thermodynamics of Power Systems	38	10
Control System Principles	36	50
Systems Dynamics	36	36
Applications of Numerical Methods to Mechanical Systems	33	33
Analysis and Design of Manned Systems	19	25

Mechanical Engineering (continued)	#	Status
Wave Propagation	16	60
Geothermal Energy	12	33
Modeling of Manned Systems	9	0
Other	38	57
Naval and Ocean Engineering	50	44
Power and Propulsion of Marine Structures	46	68
Computer Simulation of Marine Systems	41	37
Hydromechanics of Ship Design	40	50
Marine Structures	40	42
Structural Design	39	31
Oceanographic Systems	36	16
Hydroacoustics - Noise	34	36
Propulsion Hydrodynamics	31	45
Marine Systems Control	24	57
Power Systems	24	42
Marine Resources - Utilization	21	38
Energy Conversion Systems	17	28
Other	23	77

A50

	#	Status
Nuclear Engineering	27	30
Nuclear Power Plants	31	41
Nuclear Power Plants Analysis and Design	24	42
Nuclear Reaction Operations	22	50
Nuclear Waste	19	54
Nuclear Power Reactors	15	28
Computer Simulation of Reactors	13	80
Nuclear Fuel Cycle Management	11	33
Nuclear Reactor Analysis and Control	11	50
Reactor Analysis and Design	4	0
Other	7	83
Physics*	35	17
Electro-optics	31	31
Lasers	24	22
Optics	22	27
Acoustics	21	22
Astronomy	18	10
Solid State Physics	13	42
Electronics	12	16
Space Physics	11	50
Fusion and Plasma	10	16
Astrophysics	9	60
Material Science	9	25
Physics Education	9	25
Engineering Physics	8	25
Relativity	8	42

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*Number of requests by engineers only (not including separate survey of physicists.)

A51

Physics (continued)	#	Status
Nuclear Physics	7	33
Applied Physics	7	0
Medical Physics	7	0
Health Physics	6	0
Geophysics	6	0
Quantum Mechanics	6	50
Chemical Physics	6	50
Philosophy of Physics	6	0
Statistical and Thermal Physics	6	33
Atmospheric Physics	5	0
Physical Metallurgy	5	50
Mathematical Physics	5	100
General Physics	5	100
Atomic and Molecular Physics	4	0
Fluids	4	50
Electromagnetism	4	0
History of Physics	4	100
Elementary Particles and Fields	3	50
Biophysics	3	0
Polymer Physics	3	0
Nuclear Reactor Physics	3	0
Accelerator Physics	3	100
Cosmic Rays	2	50
X-Ray Diffraction	1	100
Low Temperature Physics	1	0
Nuclear Magnetic Resonance	0	0

	#	Status
Other Areas	36	10
Report Writing and Presentation	236	38
Accounting	174	18
Psychology	50	33
Ethics	36	37
English	31	15
Sociology	21	30
Other	472	40

Some Recent Graduate - level courses in Microprocessor Systems Design and Analysis at Universities in the Greater Washington DC Metropolitan area.

University	Most recent Offering	Enrollment	Number of Times Course Offered
Catholic[a]	Fall 1980	14	2
George Mason	Fall 1980	20	1
George Washington	Fall 1980	20	1
Howard [a, b]	Spring 1980	12	2
Maryland	Spring 1980	20	1
Virginia Tech[b]	Spring 1980	15	1

[a] The course enrollment reached the limit set by equipment availability.

[b] The course offered has an undergraduate number, but it is open to graduate students for graduate credit.

A54

1. What category best describes your organization?

	Number	Percent
Industry or business	55	38
Consulting firm	73	50
Educational institution	1	1
U.S. Government (military)	2	1
U.S. Government (civilian)	8	6
State or local government	0	0
International agency	0	0
Professional association	2	1
Other	4	3

2. Which of the following activities best characterizes your organization?

	Number	Percent
Primarily engaged in engineering or scientific R&D	85	59
Primarily engaged in other activities	55	38
No response	4	3

3. (a) What is the number of engineers and scientists employed by your organization within the greater Washington, DC area?

Range	Number	Percentage
0-10	47	33
11-25	31	21
26-50	24	17
51-100	9	6
101-200	11	8
201-300	3	2
301-400	1	1
401-500	3	2
501-1000	4	3
>1000	4	3
No response	6	4

3. (b) What is the number of persons employed by your organization within the greater Washington, DC area?

Range	Number	Percentage
0-10	11	8
11-25	30	21
26-50	28	19
51-100	26	18
101-200	14	10
201-300	8	6
301-400	2	1
401-500	3	2
501-1000	8	6
>1000	12	8
No response	2	1

4. How important is continuing education for the professional staff of your organization?

	Number	Percent
very important	62	43
moderately important	56	39
slightly important	21	15
not important	3	2
no response	2	1

5. Approximately what proportion of your organization's professional staff needs in continuing education has been met by in-house company-sponsored programs over the past two years?

	Number	Percent
virtually 100%	6	4
50 - 99%	16	11
25 - 49%	21	15
1 - 25%	45	31
virtually zero	52	36
no response	4	3

6. What financial support (percentage of cost) does your organization provide in the form of a direct grant for the following expenses associated with continuing education?

Percentage* of organizations which pay 100% (>50%) of the cost of the indicated expenditure.

Expenditure	Degree Program	Non-Degree Credit	Non-Credit
Tuition and fees	32 (60)	40 (60)	33 (45)
Books and materials	24 (33)	24 (36)	23 (31)
Travel expenses	8 (8)	15 (17)	20 (22)
Per diem	6 (6)	13 (15)	18 (20)
Released time allowed	11%	24%	26%

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*Non-response to various parts of this question averaged 40%. The percentages given are a percentage of all returned questionnaires. Percentages would be significantly higher if expressed as a percentage of those who filled in this question.

7. Approximately how many employees were sponsored to some degree in college or university courses for credit during the past year?

Range	Number	Percent
0	29	21
1-5	61	41
6-10	16	11
11-20	9	6
21-50	14	10
51-500	5	4
501-1000	0	0
over 1000	3	2
no response	7	5

8. Has any university offered courses for credit on your site, either live or televised during the last two years?

	Number	Percent
Yes, live	11	7
Yes, TV	5	3
Yes, computer-based	2	1
No	126	86
No response	4	3

(Are you interested in exploring the possibility?)

Yes: 31 No: 91

9. How effectively have each of the following forms of continuing education met your organization's needs in science and engineering? (Percentages given in parenthesis total 100% when "no experience" is excluded.)

Category of Course	Very effectively (%)	Moderately effectively (%)	Slightly effectively (%)	Ineffectively (%)	No experience (%)
College credit courses applied towards a graduate science or engineering (S&E) degree	22	33	15	2	28
	(31)	(46)	(21)	(3)	-
Professional society S&E Short courses	21	36	16	2	26
	(28)	(49)	(22)	(3)	-
In-house sponsored short courses or work-shops (S&E)	13	20	10	2	55
	(29)	(44)	(22)	(4)	-
College S&E non-credit courses (including short courses)	13	37	16	2	31
	(19)	(54)	(23)	(3)	-
Short courses sponsored by another agency	10	15	10	2	62
	(26)	(39)	(26)	(5)	-
College credit S&E courses not applied towards a graduate degree	16	25	23	6	31
	(23)	(36)	(33)	(9)	-

A60

10. Considering only continuing education provided by colleges and universities for credit, how would you rate the effectiveness of the following continuing education programs in meeting your organization's needs in science and engineering? (Percentages given in parenthesis total 100% when "no experience" is excluded.)

Category of Program	Very effectively (%)	Moderately effective (%)	Slightly effective (%)	Ineffective (%)	No experience (%)
Programs provided by local colleges or universities on their campus	29 (36)	35 (43)	14 (17)	4 (5)	19 -
Programs provided by in-state universities at an extension campus	16 (27)	21 (36)	13 (22)	8 (14)	41 -
Programs provided by out-of-state universities at an extension campus	8 (20)	11 (27)	10 (24)	12 (29)	59 -
Live programs provided by universities on your own site	6	5	3	2	84
TV or videotaped programs provided by universities on your own site	2	2	2	3	91

11. Considering only non-credit continuing education, how would you rate the effectiveness of the following program formats in meeting your organization's needs in science and engineering? (Percentages given in parenthesis total 100% when "no experience" is excluded.)

Program Format	Very effective (%)	Moderately effective (%)	Slightly effective (%)	Ineffective (%)	No experience (%)
seminars and symposia	26	45	11	3	15
	(31)	(53)	(13)	(4)	-
short courses	16	52	9	3	21
	(20)	(66)	(11)	(4)	-
self-study	3	19	25	9	44
	(5)	(34)	(45)	(16)	-
computer-based instruction	4	8	3	4	80
video-taped instruction	5	5	7	5	78
live video with "talk-back"	1	2	1	4	93

12. How important have each of the following barriers been to your organization's professional staff in seeking continuing education in the past?

Barriers	Very significant barrier (%)	Moderately significant barrier (%)	Slightly significant barrier (%)	Insignificant barrier (%)
Staff too busy	33	36	13	19
Topic not available	31	33	19	15
Inconvenient time	26	34	20	21
Inconvenient location	29	29	20	22
Cost	16	21	25	37
Educational level too low	9	17	21	51
Staff lacks incentive	5	19	29	47
Lack of publicity on course	6	13	17	63
Educational level too high	4	8	14	73
Previous bad experience	3	8	12	73
No mechanism for disseminating information on courses to staff	2	3	17	77

13. To what extent is the professional staff interested in pursuing programs leading to a particular academic degree as opposed to simply taking particular courses in needed subjects?

	Number	Percent
Further academic degrees very important to most of the professional staff	26	18
Further academic degrees somewhat important to most of the professional staff.	63.5	44
Further academic degrees of little importance to most of the professional staff.	47.5	33
No response	7	5

14. To what extent should academic degree programs be changed to the professional school model? (In a professional school program lasting more than four years and leading to a professional degree there would be greater emphasis on design and professional practice as against theory and research and on non-technical subjects including writing, economics and ethics, as well.)

	Number	Percent
No opinion	32	22
Great change needed towards professional school model	32	22
Some change needed towards professional school model	56	39
No change needed	12	8
Change needed, but of a different kind	4	3
No response	9	6

15. Please indicate below the number of engineers, scientists, and technicians employed at this organization categorized according to their educational level and scpecialization.

	Highest Degree		
Engineers	Ph.D.	M.S.	B.S.
Chemical	24	76	110
Civil	21	104	273
Electrical	74	338	1090
Electronic	33	180	344
Industrial	2	16	69
Mechanical	13	81	348
Other	48	200	481
Scientists			
Astronomers	2	1	4
Biologists	399	354	1198[a]
Computer Scientists	59	306	554
Chemists	64	243	939[b]
Geologists	304	210	77
Physicists	140	197	372[c]
Other	167	169	493[d]
Technicians			413

a. 1031 from one organization

b. 737 from one organization

c. 221 from one organization

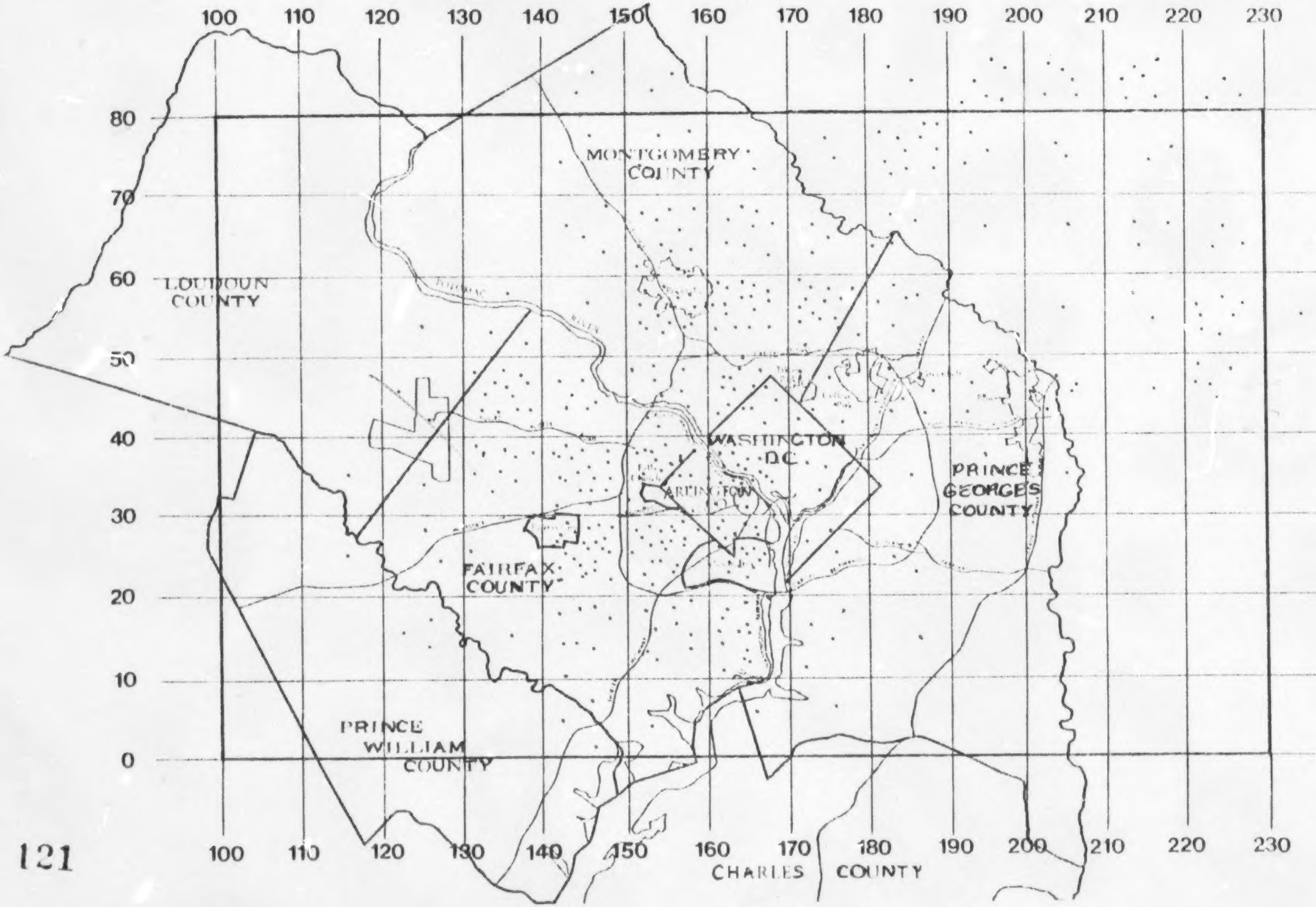
d. 289 from one organization

A66

Continuing Education Topics Most Frequently Requested

Number of Requests	Topic
13	Report writing and presentation
10	Computer engineering (general)
10	Data base management
9	Advanced programming
8	Structural analysis and design
8	Communication systems
8	Microprocessor system design and analysis
7	Civil engineering (general)
7	Electrical engineering (general)
7	Mechanical engineering (general)
6	Software engineering applications
6	Environmental impact assessment
6	Heating, refrigeration, and A/C

RESPONDENTS HOME LOCATIONS (EACH DOT EQUALS TEN PERSONS)



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MONTGOMERY COUNTY
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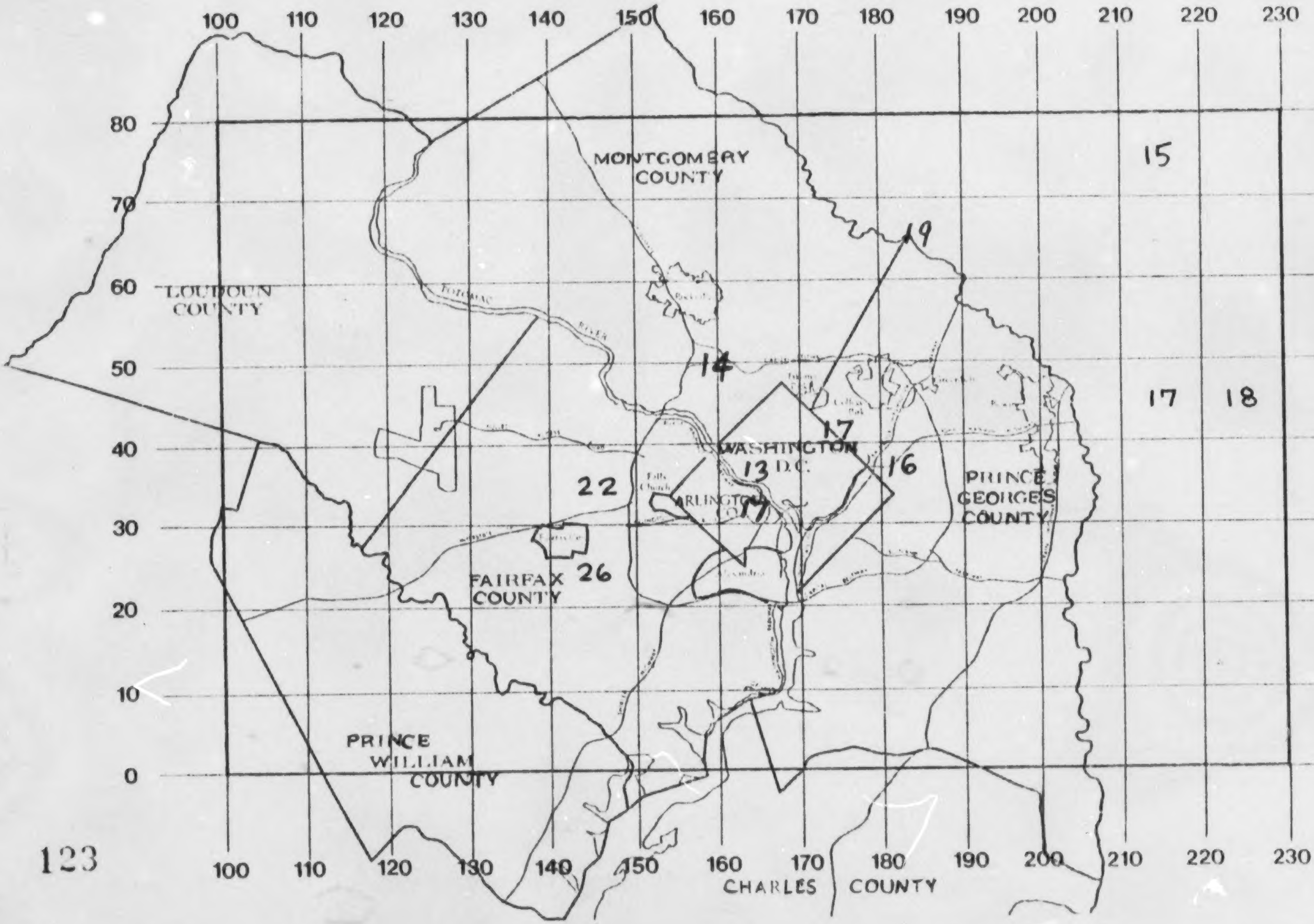
FAIRFAX COUNTY
PRINCE WILLIAM COUNTY
CHARLES COUNTY

RESPONSE RATE FOR SELECTED LOCATIONS BY ZIP CODE



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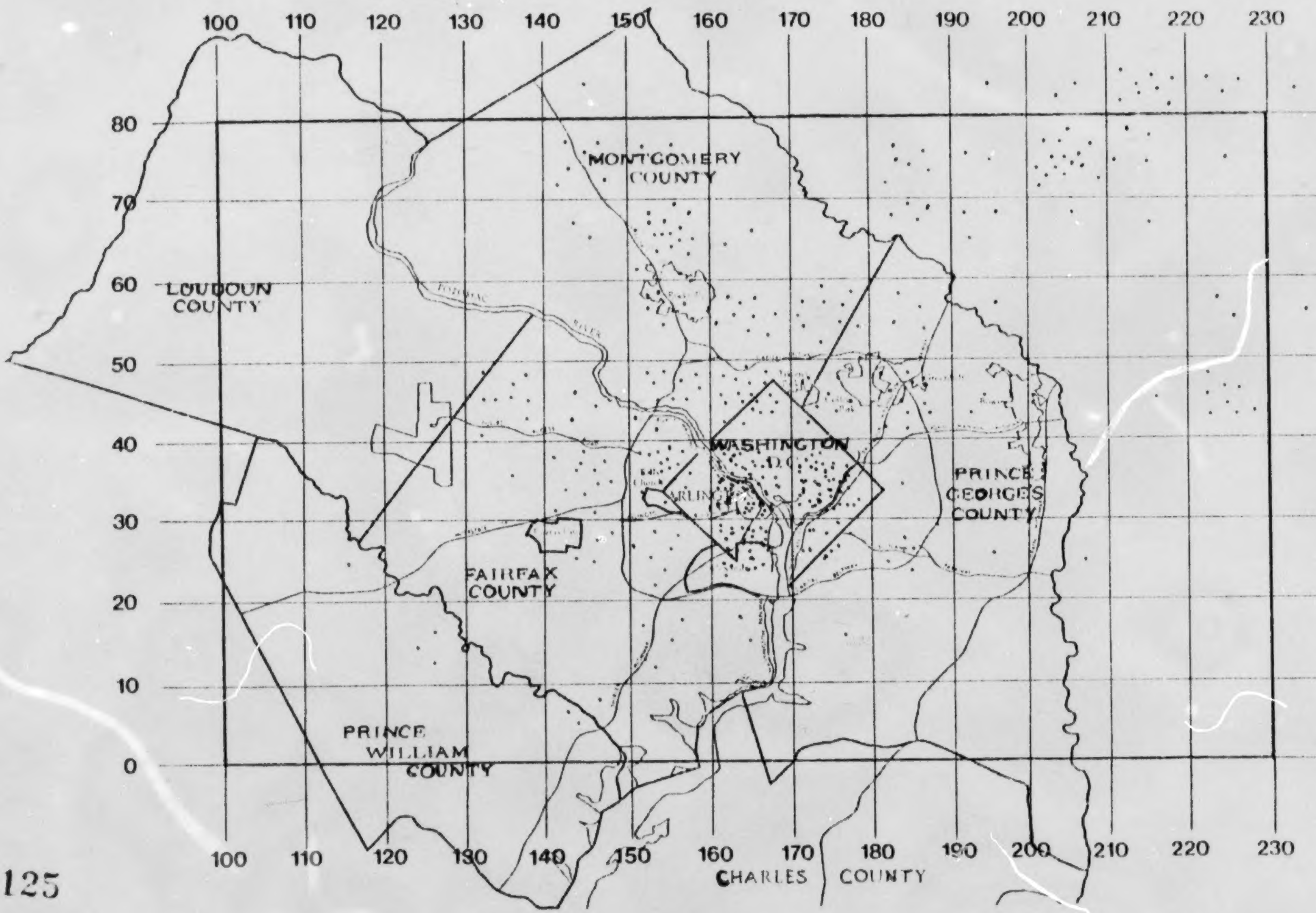
B2

RESPONDENTS WORK LOCATIONS (EACH DOT EQUALS TEN PERSONS)



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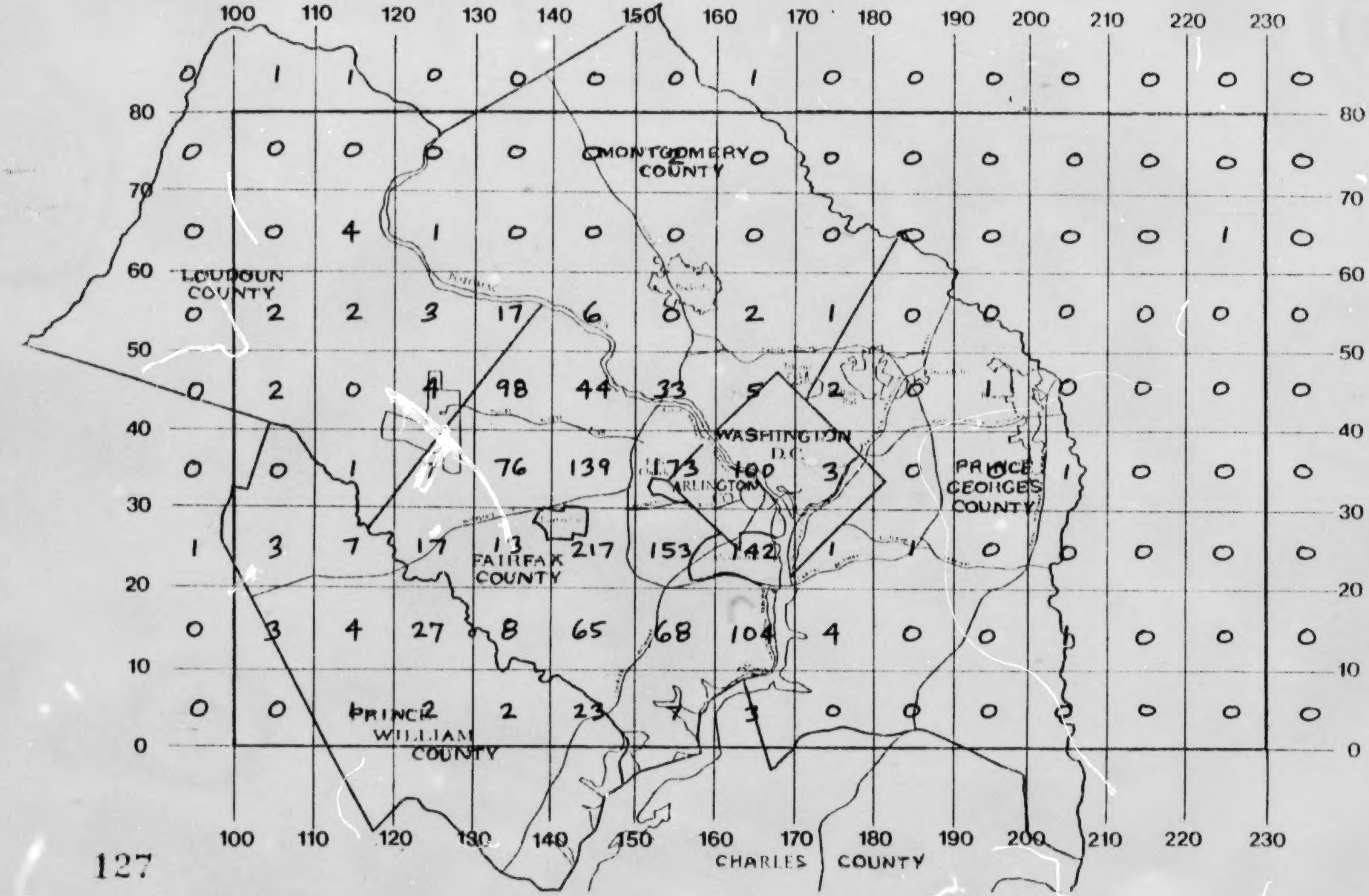
CHARLES COUNTY
POTOMAC RIVER

B3

HOME LOCATIONS OF ENGINEERS CITING VIRGINIA RESIDENCE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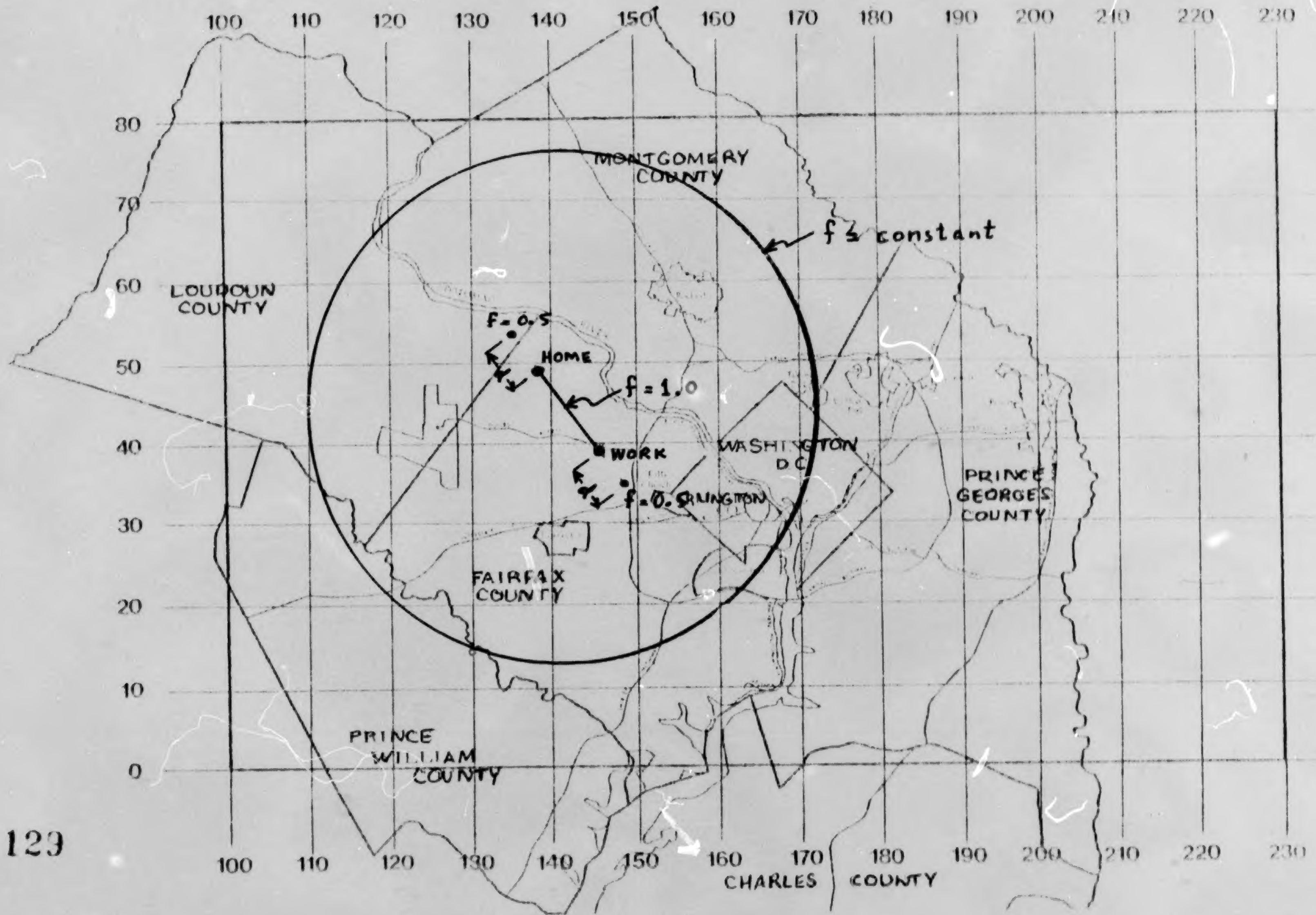
CHARLES COUNTY

CONDITIONS 1, 2, and 3 ON THE "NEED FUNCTION" f(x,y)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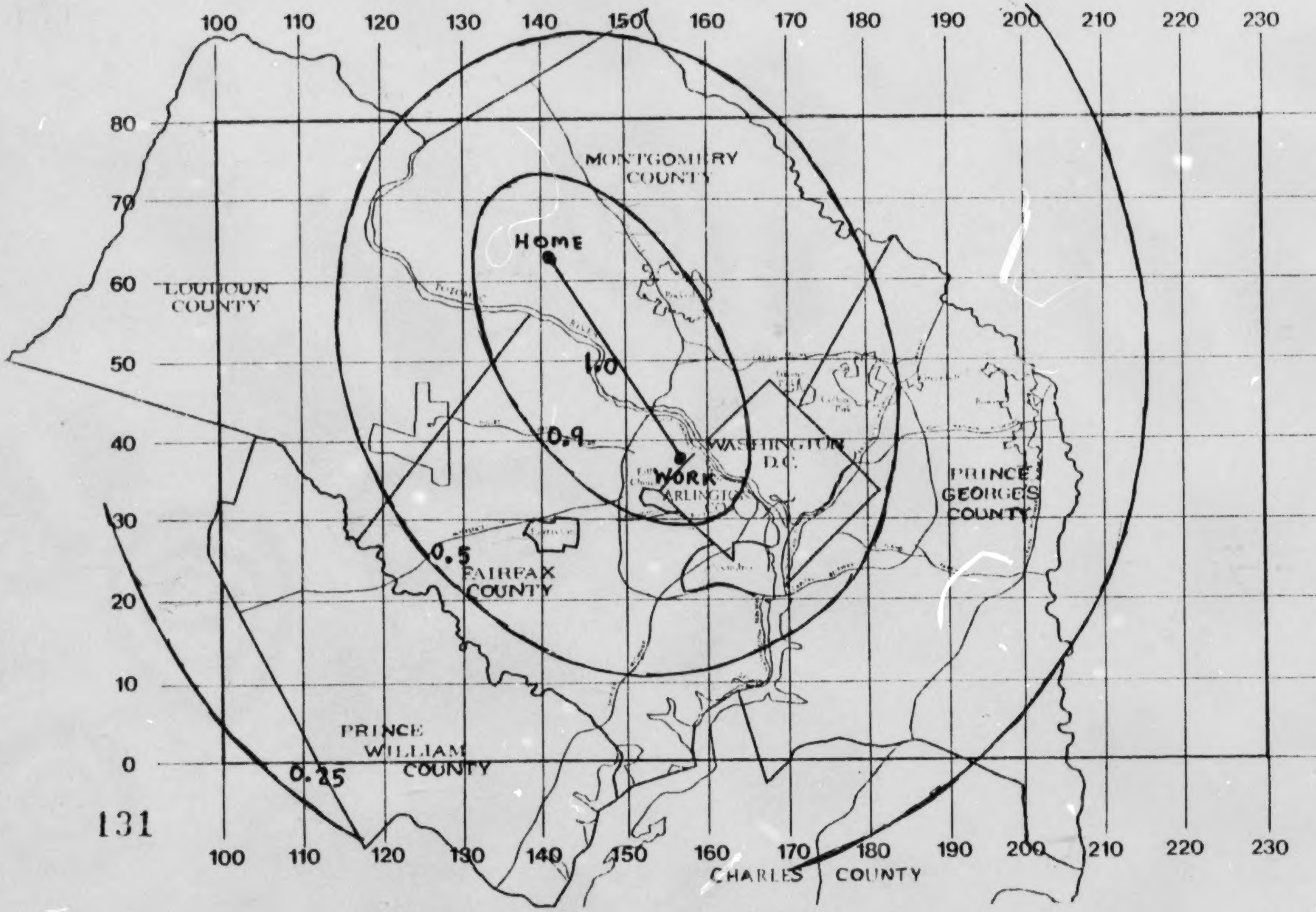
NEED CONTOURS FOR THE INDIVIDUAL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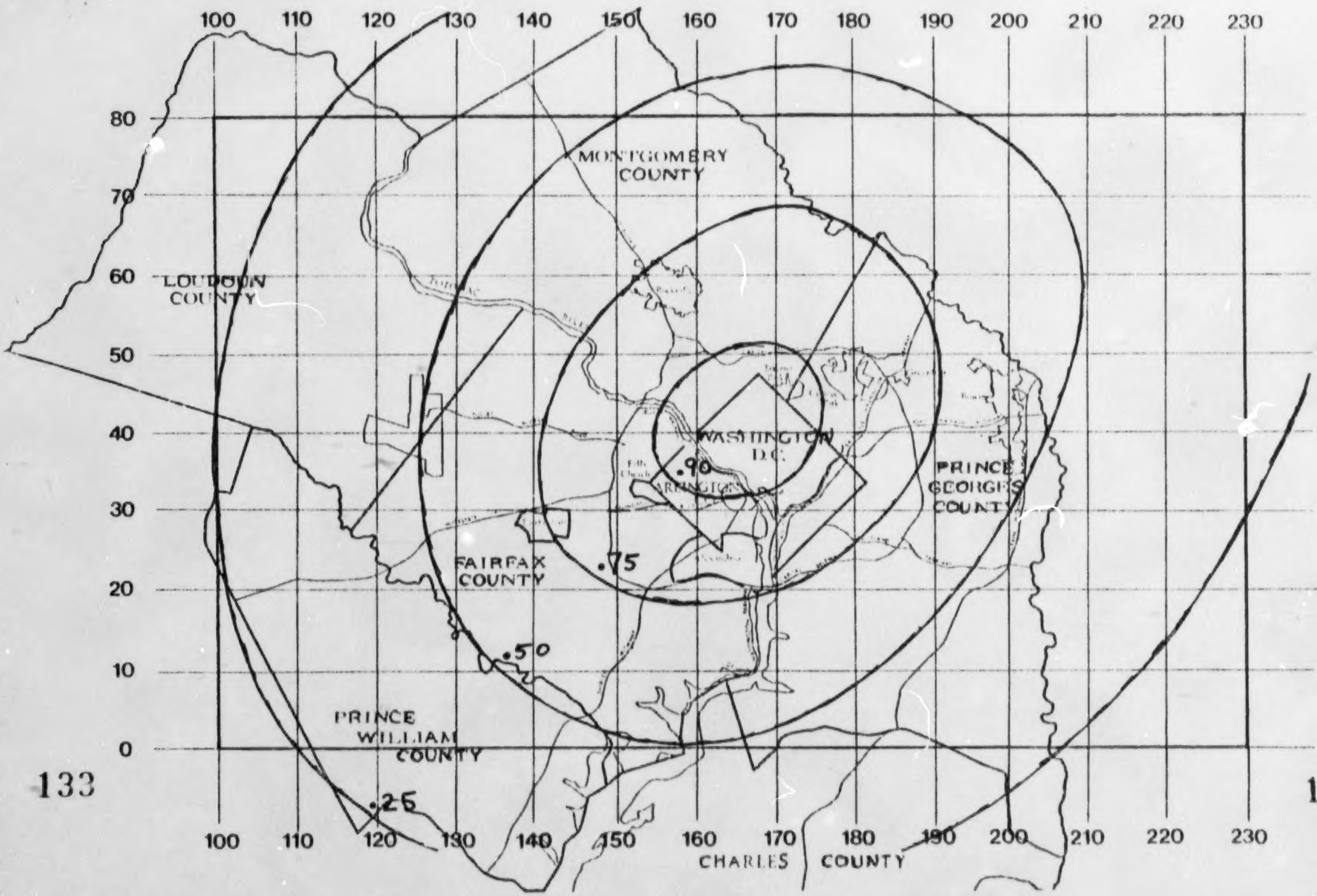
B6

NEED FOR MICROPROCESSOR SYSTEMS ANALYSIS AND DESIGN COURSE (N=212.8)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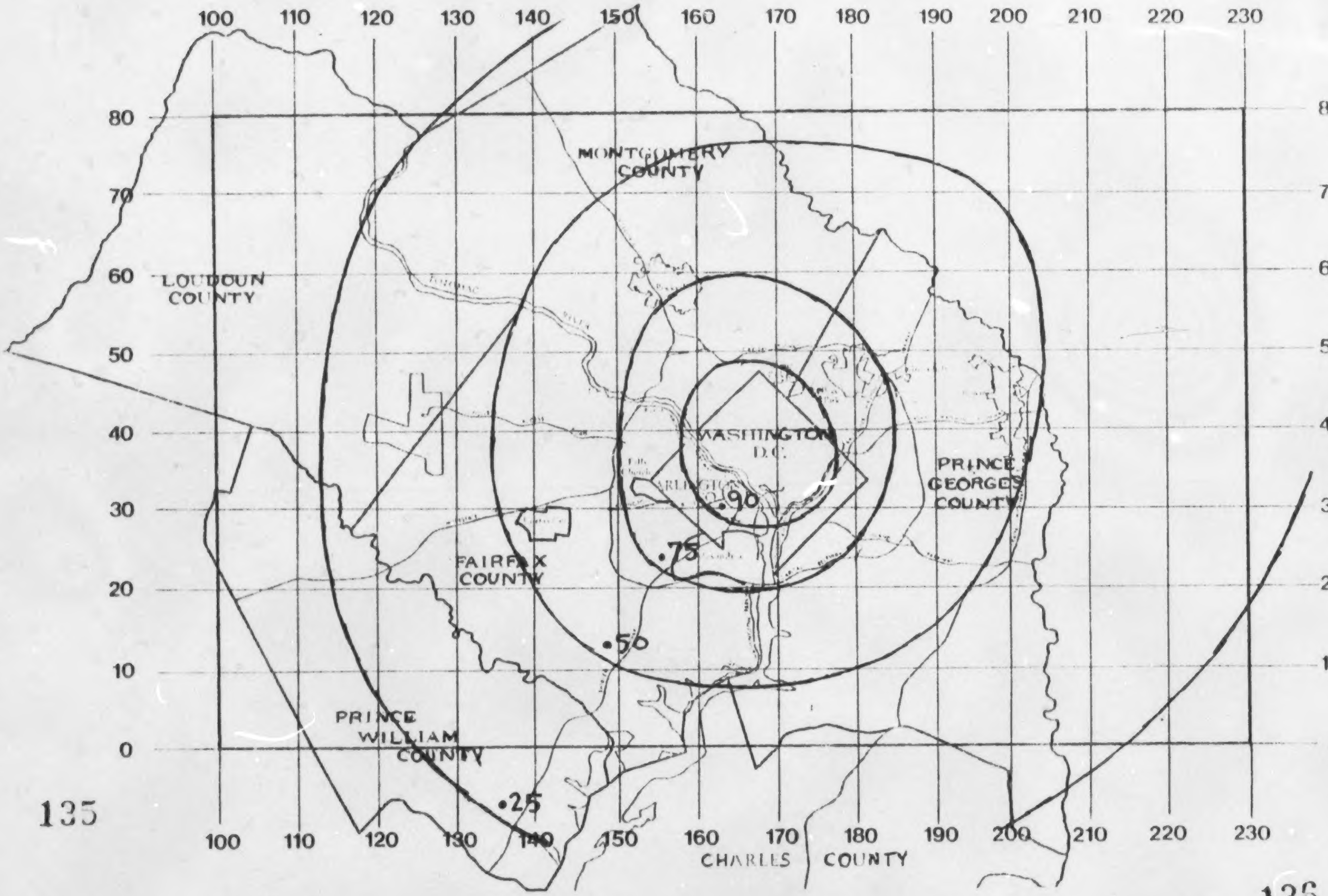
NEED FOR POWER SYSTEMS COURSE (N=71.9)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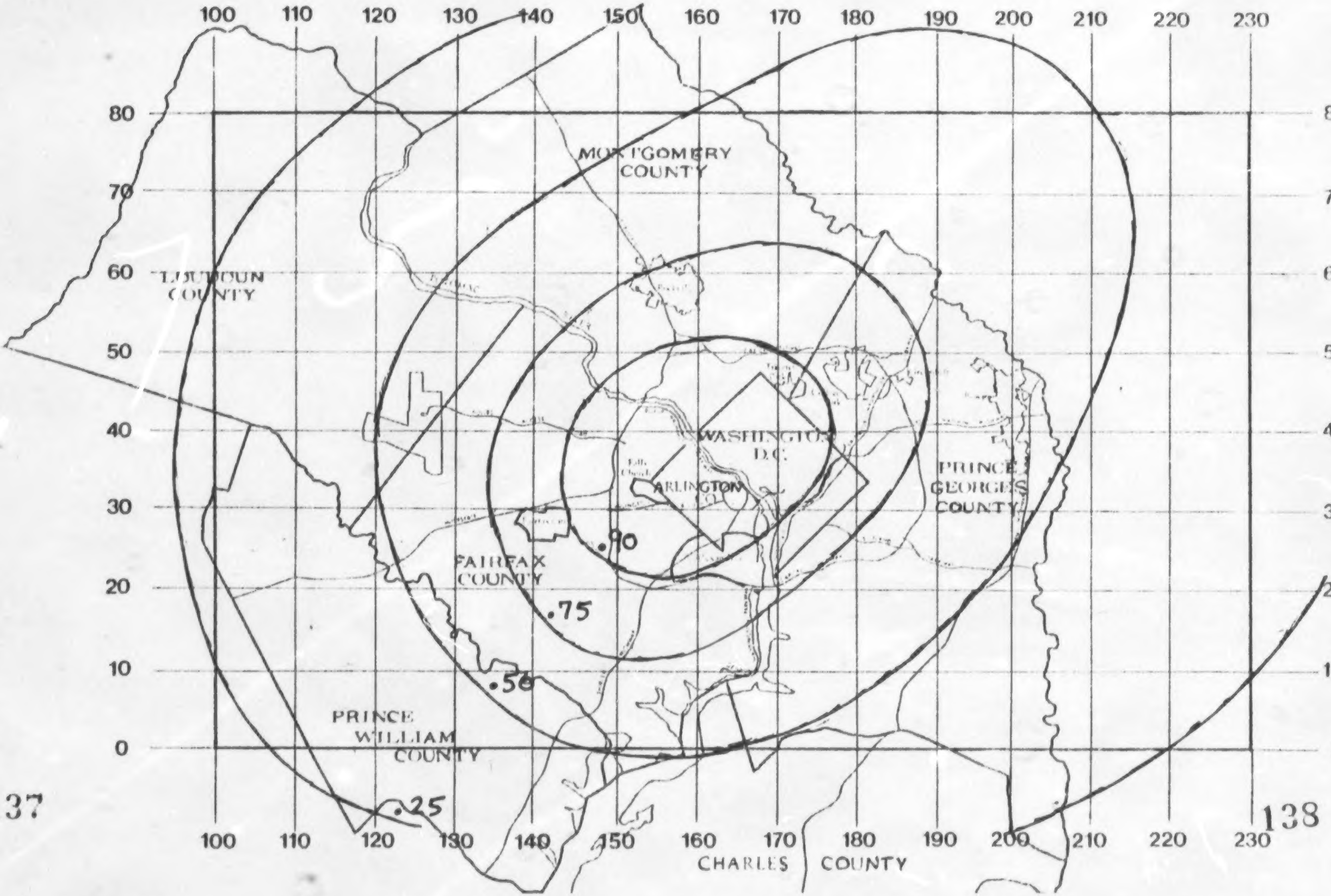
B9

NEED FOR WATER RESOURCE SYSTEMS COURSE (N=71.7)



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PRINCE GEORGES COUNTY
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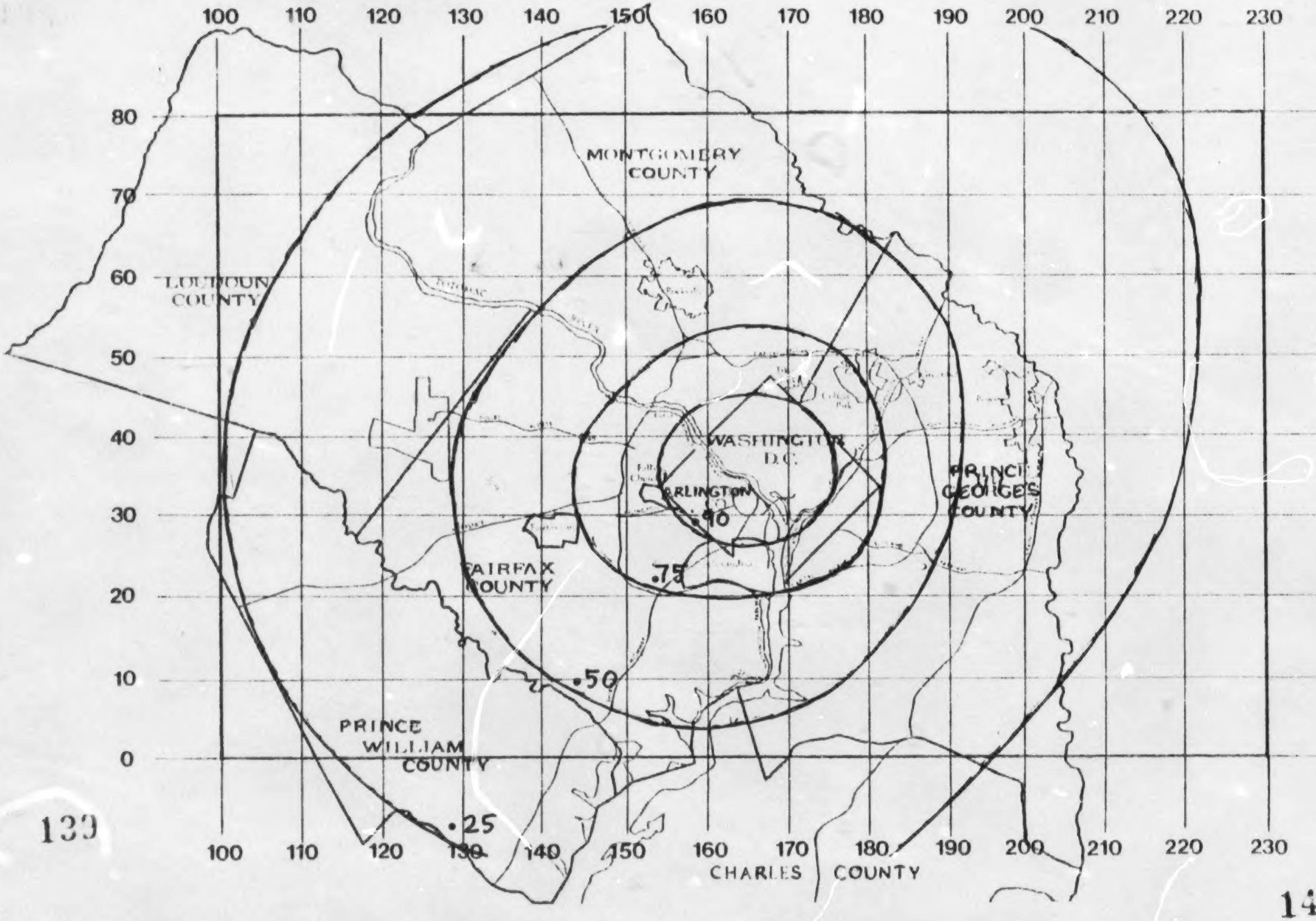
NEED FOR ENGINEERING AND PUBLIC POLICY COURSE (N=99.4)

Bio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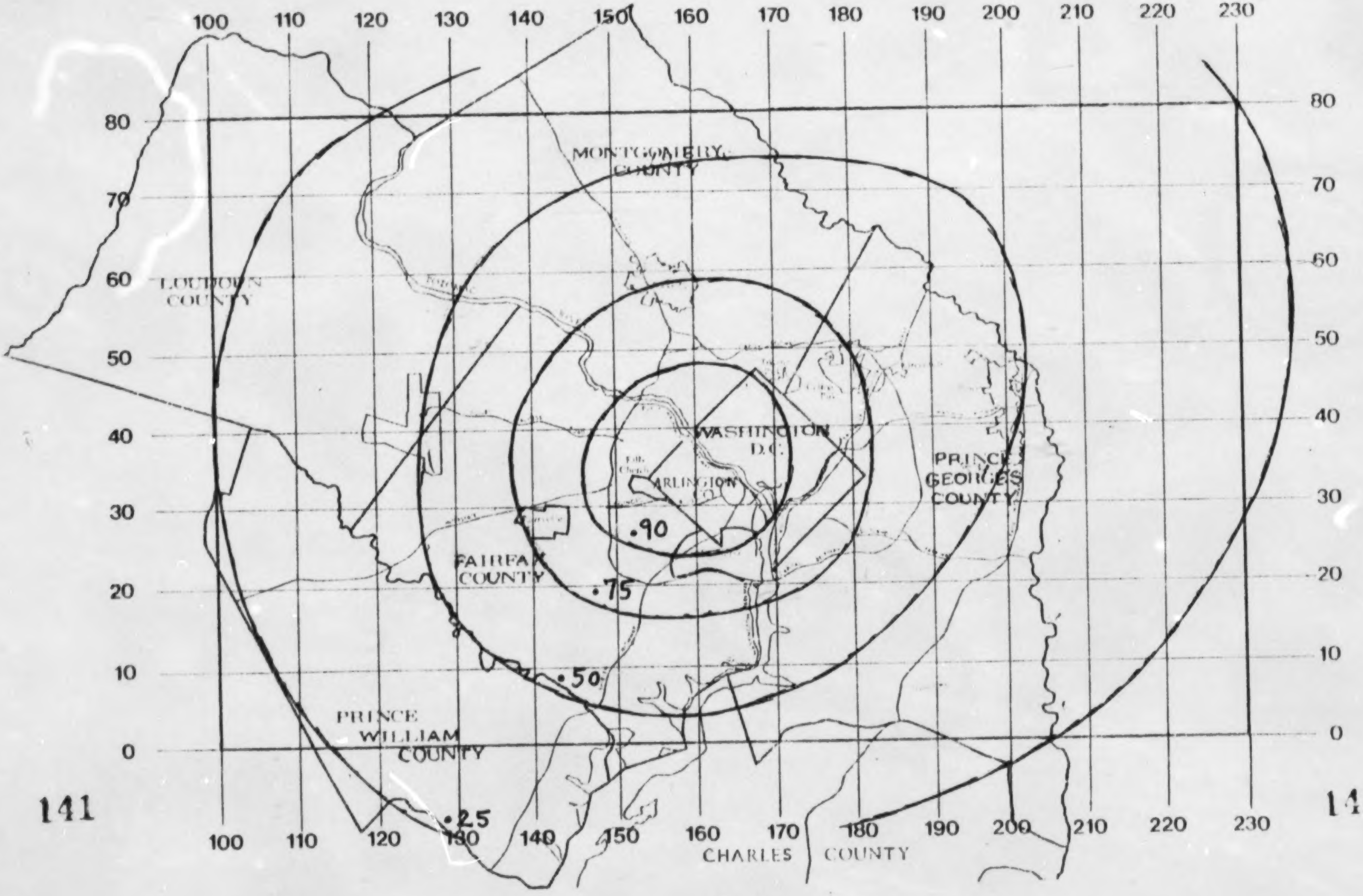
NEED FOR COMMUNICATION SYSTEMS COURSE (N=253.7)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ARLINGTON CO.
Falls Church
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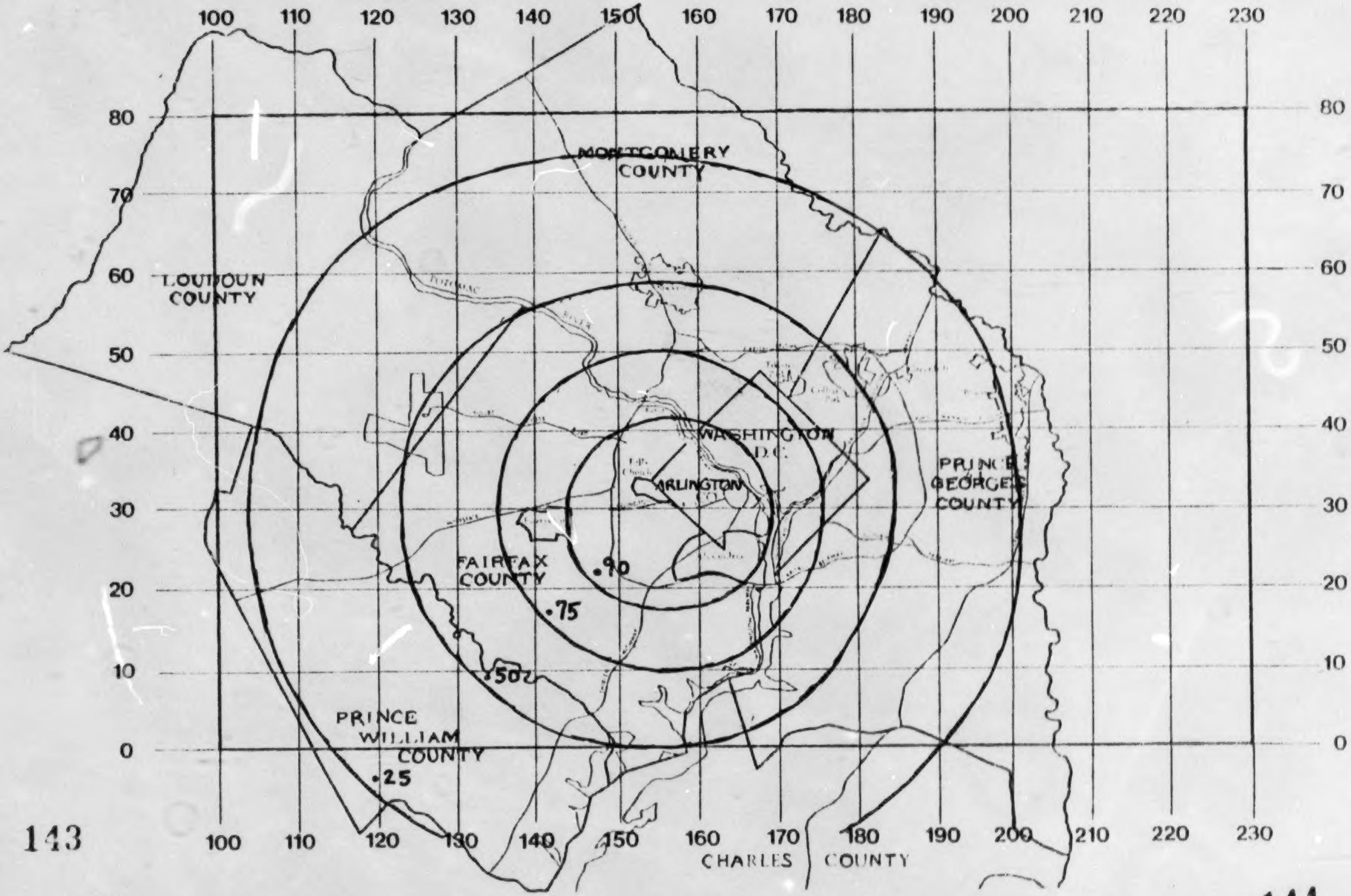
NEED FOR ALL TOPICS COMBINED (VIRGINIA RESIDENTS ONLY)



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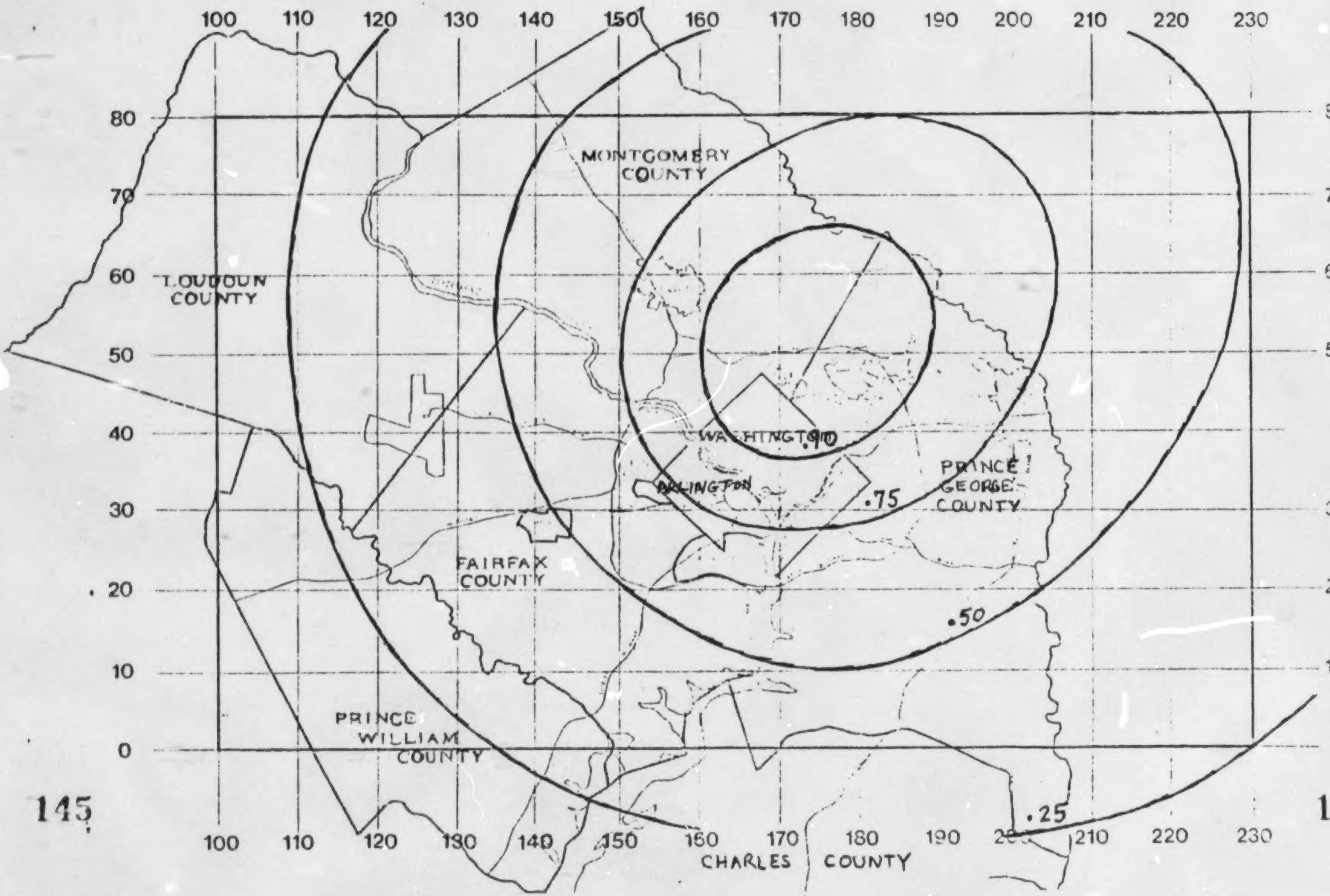
NEED FOR ALL TOPICS COMBINED (MARYLAND RESIDENTS ONLY)



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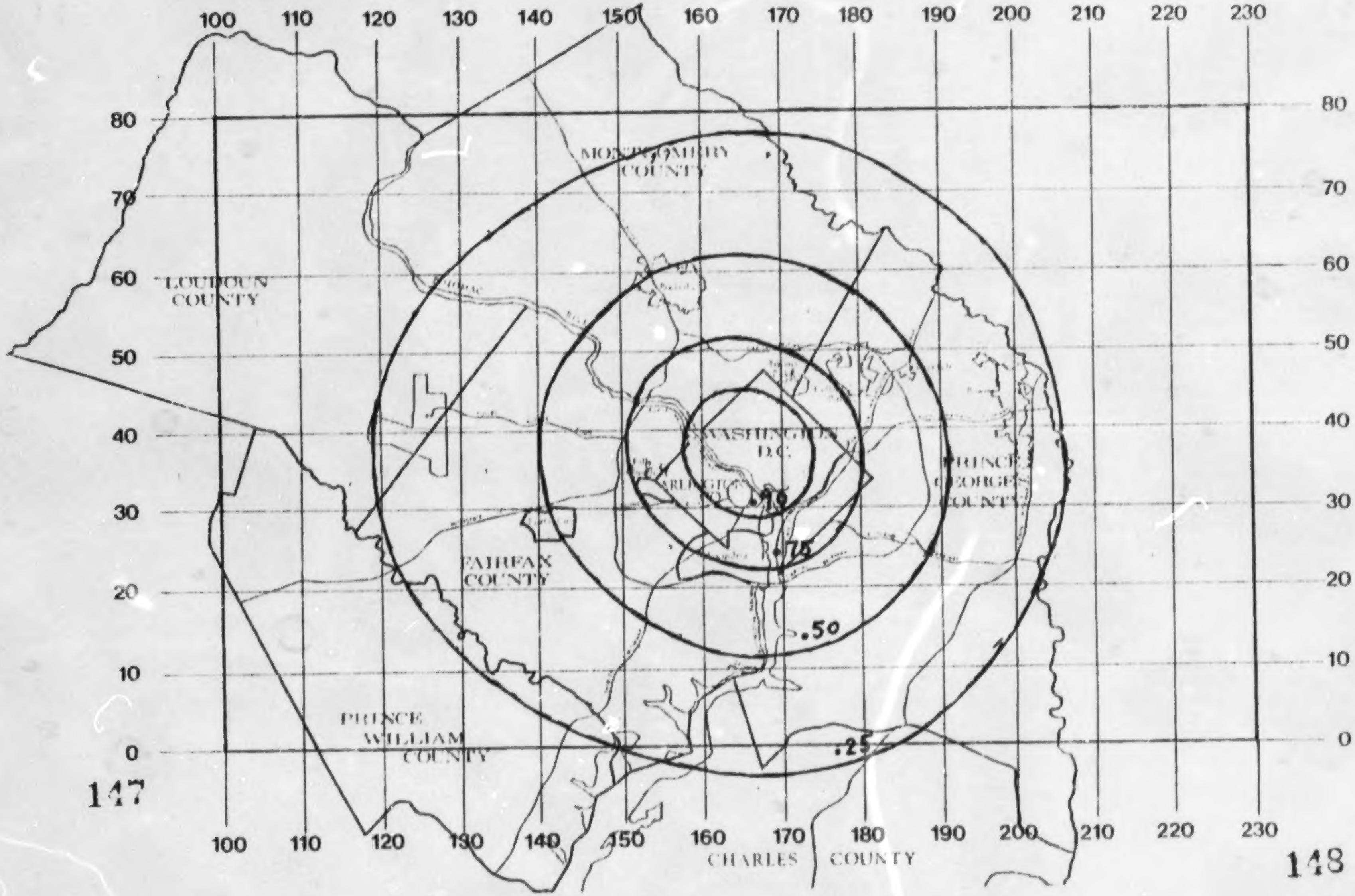
NEED FOR ALL TOPICS COMBINED (WASHINGTON D.C. RESIDENTS ONLY)



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GEORGE MASON UNIVERSITY
THE STATE UNIVERSITY IN NORTHERN VIRGINIA • 4400 UNIVERSITY DRIVE • FAIRFAX • VIRGINIA • 22030

SURVEY OF CONTINUING EDUCATION NEEDS OF ENGINEERS

Dear Colleague:

The enclosed survey is being sent to selected engineers in the greater Washington, D.C. metropolitan area to determine this community's continuing education needs in engineering For the Survey purposes, the term continuing education includes all activities such as courses, seminars, workshops, conferences, lecture series, and self-study, that may be offered by universities, professional societies, your own employer or another agency. The Survey is being conducted by George Mason University under a National Science Foundation grant for the benefit of all area educational institutions. With your help we hope to identify area engineer's most urgent educational needs for the future and determine the magnitude and effectiveness of existing educational efforts.

Any information that you supply will be confidential and disseminated only in statistical form. I recognize that asking you to fill out this survey is an imposition on your time, and I thank you in advance for your reply. The questionnaire is shorter than it appears since over half the pages consist of reference tables and a map, and in fact, it probably should take no more than 15 minutes to fill out. Should you not have any interest in the subject of continuing education for engineers would you kindly check the box below and return the survey in the enclosed postage-paid envelope so that we need not bother you with a follow-up mailing. Please contact me at 703-323-2302 if you have any questions.

Sincerely yours,

Robert Ehrlich

Dr. Robert Ehrlich
Engineering Survey
Project Director
George Mason University

☐ I am not interested in the subject of continuing education for engineers, and am returning the survey without filling it out.

Name ____________________ (please print)

Zip code __________

C1

NOTE: Should you, for any reason, prefer not to answer all of the questions concerning your background, the partially completed questionnaire would still be very useful to us.

1. Your age? (Circle the appropriate letter)

   a. under 20
   b. 20 - 24
   c. 25 - 34
   d. 35 - 44
   e. 45 - 54
   f. 55 and over

2. What is your current employment status?

   g. employed full- time
   h. employed part-time
   i. not employed
   j. retired

3. Which of the numbered categories of occupations in Reference list A on page 9 best describes your present principal employment?

   ☐☐
   code

4. How many years have you been employed with your present organization?

   ☐☐

5. How many years of professional science or engineering work experience have you had?

   ☐☐

6. Which category best describes the type of organization of your principal employment?

   a. industry or business
   b. consulting firm
   c. educational institution
   d. U.S. government (military)
   e. U.S. government (civilian)
   f. state or local government
   g. international agency
   h. self-employed
   i. professional association
   j. other (specify): ____________

7. In which one of the following activities are you most involved?

   k. Testing/evaluation
   l. Management or Administration
   m. Basic Research
   n. Design
   o. Applied Research
   p. Development
   q. Production
   r. Teaching
   s. Consulting
   t. Sales, marketing
   u. Quality control
   v. Construction
   w. Other (specify) ____________

8. Do you hold professional registration?

   x. yes, in engineering
   y. yes, in other field (specify): ____________
   z. no

9. What academic degrees have you received? (See Reference list B on page 10 for academic fields and code numbers)

Degree	Year	Major Field Code #
Bachelors	☐☐	☐☐
Masters	☐☐	☐☐
Doctorate	☐☐	☐☐

10. Are you presently working towards a degree? (See Reference list B on page 10).

   a. No
   b. Yes, Degree: ☐☐
   Major field code ☐☐
   Year expected: ☐☐

11. Do you plan to possibly work towards a degree in the future? (See Reference list B on page 10).

c. No

d. Yes, Degree: ☐☐

Major field code ☐☐

Year expected to start: ☐☐

12. To what extent are you interested in pursuing a program leading to a particular academic degree, as opposed to simply taking courses in needed subjects?

e. further academic degree very important

f. further academic degree somewhat important

g. further academic degree of little importance.

13. To what extent should academic degree programs be changed to the professional school model? (In a professional school program, lasting more than four years and leading to a professional degree, there would be greater emphasis on design and professional practice, as against theory and research, and on non-technical subjects including writing, economics and ethics, as well.)

h. great change needed in emphasis towards practice-oriented professional school model

i. some change needed in emphasis towards practice-oriented professional school model

j. no change needed

k. no opinion

l. change is needed, but of a different kind (please specify):

14. For each of the following forms of continuing education, how many courses in science or engineering have you participated in during the last two years? (Indicate number of courses in each case.)

#___ College credit courses applied towards a graduate science or engineering (S&E) degree.

#___ College credit S&E courses not being applied towards a graduate degree.

#___ College S&E non-credit courses, (including short courses).

#___ Professional society short courses (S&E).

#___ Employer-sponsored short courses or workshops (S&E).

#___ Short courses sponsored by another agency. Please specify agency:

____

15. How effectively have each of the following forms of continuing education met your continuing education needs in science and engineering?

V - very effectively
M - moderately effectively
S - slightly effectively
I - ineffectively
N - no experience on which to judge

___ College credit courses applied towards a graduate science or engineering (S&E) degree.

___ College credit S&E courses not being applied towards a graduate degree.

___ College S&E non-credit courses (including short courses).

___ Professional society short courses (S&E).

___ Employer-sponsored short courses or workshops (S&E).

___ Short courses sponsored by another agency. Please specify agency:

____

16. Considering only continuing education provided by colleges and universities for credit, how would you rate the effectiveness of the following continuing education programs you have taken?

V - very effective
M - moderately effective
S - slightly effective
I - ineffective
N - no experience on which to judge

___ Programs provided by local colleges and universities on their campus.

___ Programs provided by in-state universities at an extension campus. (Consider D.C. a "state".)

___ Programs provided by out-of-state universities on an extension campus.

___ Live programs provided by universities at your place of employment.

___ Televised or videotaped programs provided by universities at your place of employment.

17. Consider only non-credit continuing education how would you rate the effectiveness of the following program formats in meeting your professional needs?

V - very effective
M - moderately effective
S - slightly effective
I - ineffective
N - no experience on which to judge

___ Seminars and symposia

___ Short courses

___ Video-taped instruction

___ Live video with "talk-back" capability

___ Live video without "talk-back" capability

___ Self-study courses

___ Computer-based instruction

___ Other (specify): ______________

18. How important have each of the following barriers been to your seeking continuing education in the past?

V - very significant barrier
M - moderately significant barrier
S - slightly significant barrier
I - insignificant barrier

___ inconvenient location

___ inconvenient time

___ insufficient employer financial support

___ course not available

___ course poorly presented

___ educational level too high

___ educational level too low

___ lack of time

___ lack of incentive

___ lack of knowledge that course was offered

___ other, please specify:
____

C4

19. It is quite possible that you may need continuing education in certain areas, quite apart from any consideration of degrees or credits. Below you are asked to list two or more topics, and thereby indicate your priorities for areas in which you need continuing education. Select your topics from Reference list C on pages 11 - 14.

FIRST TOPIC FROM LIST C: ____________________ Code Number ☐☐☐☐
(see pages 11 - 14)

	1st choice	2nd choice
. Preferred supplier for this topic...........................	☐	☐

1 = college, 2 = prof. society, 3 = employer, 4 = self
5 = other (specify __________)

	1st choice	2nd choice
. Preferred format for this topic	☐	☐

(1 = credit course, 2 = non-credit, 3 = short course,
4 = lecture series, 5 = self-paced)

. Present status for this topic.. ☐
(1 = not being offered at all, 2 = offered, but not enough to satisfy demand, 3 = offered enough to satisfy demand, 4 = unknown)

. Persistence of your need:
- How many months have you had a need for this topic?.................... ☐☐
- How many months do you expect to continue to have this need?........... ☐☐
(If your need is for the foreseeable future, enter 99.)

. Preferred location:
The likelihood of your attending a particular course which meets once a week would surely decrease the more miles you have to travel,

	(home)	(business)
- How many miles from your home or business would the course have to be offered before the likelihood of your attending dropped to 50%....................................	☐☐	☐☐

- How advantageous would it be to have the course offered at your place of business? .... ☐☐
(1 = extremely advantageous, 2 = moderately advantageous
3 = unimportant, 4 = prefer off-site location)

. Preferred time.. ☐
(1 = 4 p.m., 2 = 5 p.m., 3 = 6 p.m., 4 = 7 p.m.,
5 = 8 p.m., 6 = 9 p.m., 7 = before 4 p.m., 8 = weekends,
9 = other - please specify) ______________________________

C5

SECOND TOPIC FROM LIST C: ____________________ Code Number ☐☐☐☐
(see pages 11 - 14)

	1st choice	2nd choice
. **Preferred supplier** for this topic.................... (1 = college, 2 = prof. society, 3 = employer, 4 = self) 5 = other (specify ____________________)	☐	☐

	1st choice	2nd choice
. **Preferred format** for this topic .... (1 = credit course, 2 = non-credit, 3 = short course, 4 = lecture series, 5 = self paced)	☐	☐

. **Present status** for this topic .... ☐
(1 = not being offered at all, 2 = offered, but not enough to satisfy demand, 3 = offered enough to satisfy demand, 4 = unknown)

. **Persistence of your need:**
- How many months have you had a need for this topic?.............. ☐☐
- How many months do you expect to continue to have this need? .... ☐☐
(If your need is for the foreseeable future, enter 99.)

	(home)	(business)
. **Preferred location:**		
- How many miles from your home or business would the course have to be offered before the likelihood of your attending dropped to 50%......................	☐☐	☐☐
- How advantageous would it be to have the course offered at your place of business? .... (1 = extremely advantageous, 2 = moderately advantageous 3 = unimportant, 4 = prefer off-site location)		☐☐

. **Preferred time**... ☐
(1 = 4 p.m., 2 = 5 p.m., 3 = 6 p.m., 4 = 7 p.m., 5 = 8 p.m., 6 = 9 p.m., 7 = before 4 p.m., 8 = weekends, 9 = other - please specify)

ADDITIONAL TOPICS: (Please use code numbers on pages 11 - 14)

☐☐☐☐ ☐☐☐☐ ☐☐☐☐

20. One important aspect of this Survey is to identify the geographic distribution of the need for different kinds of continuing education. For this purpose we ask that you identify the x and y coordinates of your home and place of business using the map on pages 7 - 8. Please express each coordinate accurately to the nearest unit, e.g., x = 207., y = 29.

	x-coordinate	y-coordinate
Home	☐☐☐	☐☐
Business	☐☐☐	☐☐

21. If you indicated in question 11 that you plan to work towards a degree in the future, is there a university within a reasonable commuting distance that offers the degree you plan to seek?

a. Yes

b. No

c. Don't know

22. If you have indicated that you plan to work towards a degree in the future, to what extent would relocation and full-time study be a viable option for you?

d. Relocation would present no serious problem

e. Relocation would present some problem, but I might be willing to do it, particularly if financial aid were available.

f. Relocation would not be a viable option for me.

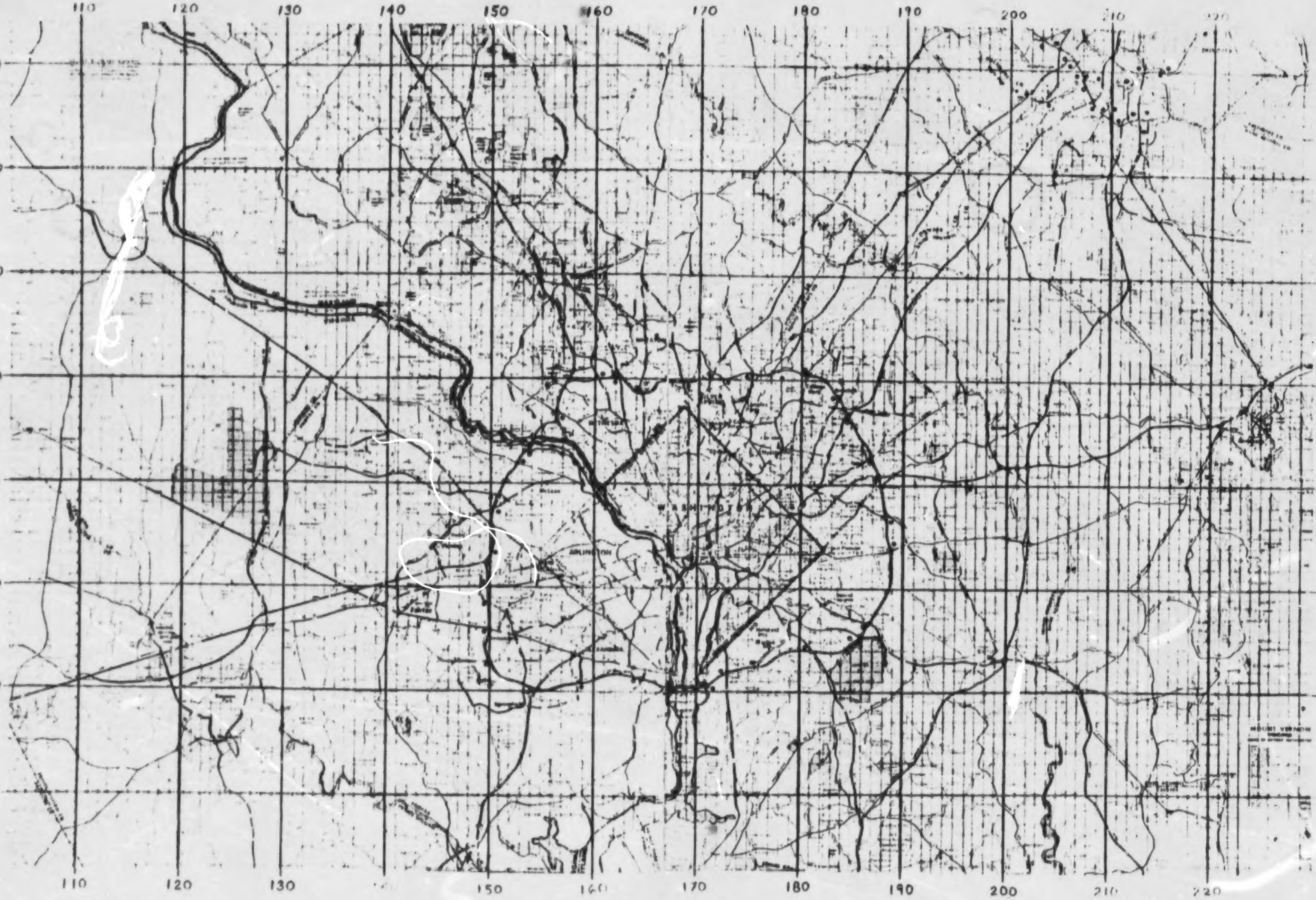
23. Name: ______________________

Street: ______________________

City & State ______________________ (zip)

Thank you for filling out this questionniare. You may feel that there are important issues that have not been adequately covered in this questionnaire. If so, please discuss them in the space on the back cover of this booklet. We would be particularly interested in any comments you might have on the effectiveness of specific continuing education offerings you have taken, ways in which the effectiveness of continuing education offerings might be improved and any suggestions you might have on any omissions or deficiencies in this questionnaire.

C7-8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C 8

REFERENCE LIST A - OCCUPATIONS

This list is to be used in answering question 3 about your occupational classification. Please scan the entire list, choose the appropriate entry and enter the code and description from this list. If you cannot find exactly the right entry, please choose the one that comes nearest to it. If none of the entries is at all appropriate, use the "Other" category (code 51) and enter a brief description in the space provided on the questionnaire.

Code #	Description
	ENGINEERS, including college professors and instructors
01	Aeronautical and astronautical
02	Agricultural
03	Chemical
04	Civil and archetictural
05	Electrical and electronic
06	Environmental & sanitary
07	Industrial
08	Mechanical
09	Metallurgical & materials
10	Mining and petroleum
11	Nuclear
12	Operations research systems
13	Other engineering field (specify)
	COMPUTER SPECIALISTS, including college professors and instructors
14	Computer programmer
15	Computer systems analyst
16	Computer scientist
17	Other computer specialist (Describe briefly under the applicable item on the questionnaire.)
	MATHEMATICIANS AND STATISTICIANS, including college professors and instructors
18	Actuary
19	Mathematician
20	Statistician
21	Operations research analyst
	PHYSICAL SCIENTISTS, including college professors and instructors
22	Atmospheric scientist, meteorologist
23	Chemist
24	Earth scientist (including geologists, geophysicists, etc.)
25	Oceanographer
26	Physicist, astronomer
27	Other physical scientist (specify)

Code #	Description
	HEALTH PROFESSIONALS, including persons who are primarily practitioners.
28	Physician or surgeon
29	Technician, dental
30	Technician, medical
31	Other health occupation (specify
	TECHNICIANS AND TECHNOLOGISTS, except medical (see 29, 30)
32	Designer, electronic parts and machine tools
33	Designer, industrial
34	Designer, other
35	Draftsman
36	Surveyor
37	Technician, biological and agricultural
38	Technician, electrical and electronic
39	Technician, construction, highways, and architectural
40	Technician, mechanical
41	Technician, other engineering
42	Technician, physical science
43	Technician, other fields (specify)
	TEACHERS
44	Teacher, elementary school
45	Teacher, secondary school
46	Teacher, college and university, excluding engineering and science (Engineering and science teachers see codes 01-27)
	ADMINISTRATORS, MANAGERS, & OFFICIALS
47	College President or Dean
48	Administrator (R&D)
49	Administrator (non R&D)
50	Self-employed proprietor
51	All other occupations (specify)

REFERENCE LIST B - MAJOR FIELDS OF STUDY

This list is to be used in answering questions 9, 10, 11 about the field(s) in which you have obtained study or training or expect to obtain such training. Please scan the entire list, choose the appropriate answer for the question and then enter the code and description in the appropriate section of questions 9 - 11. If none of the categories listed below adequately describes what you were studying or being trained in, use the "Other" category (code 00) and enter a brief description of what you were studying in the space provided on the questionnaire.

Code #	Description
	EDUCATION
52	Biological sciences education
53	Mathematics education
54	Physical sciences education
55	Trade and industrial training
56	Education, other fields
	ENGINEERING
57	Aerospace, aeronautical, astronautical, and related fields
58	Agricultural
59	Architectural
60	Chemical, petroleum refining
61	Civil, construction, transportation
62	Electrical, electronics
63	Engineering sciences, mechanics physics
64	Engineering, technology
65	Environmental/Sanitary engineering
66	General or unified
67	Industrial
68	Mechanical
69	Metallurgical, materials, ceramics
70	Mining, mineral
71	Naval architecture and marine engineering
72	Nuclear
73	Operations Research/Systems Engineering
74	Petroleum
75	Engineering, other fields

Code	Description
	MATHEMATICAL SCIENCES
76	Mathematics
77	Statistics and actuarial sciences
78	Computer sciences and systems analysis
	PHYSICAL SCIENCES
79	Astronomy
80	Chemistry
81	Geography
82	Geology and Geophysics
83	Meteorology
84	Oceanology
85	Physics
86	Physical sciences, general
87	Physical sciences, other fields
	OTHER SPECIALTIES
88	Arts, general
89	Business and commerce
90	English and Journalism
91	Fine and Applied Arts
92	Law
93	Military Science
00	Other (specify)

REFERENCE LIST C - CONTINUING EDUCATION TOPICS

This list is to be used in answering question 19 about the areas in which you desire continuing education. Please scan the list (extending through page 14) for those major headings of likely interest and choose the appropriate code numbers to enter in question 19. You may wish to enter the code number ofr either an entire broad area, e.g., aerospace - aeronautical engineering (100), or for a particular topic, e.g., aerodynamics (101). If you use the "other" category please specify the topic in the space provided in the list of topics.

Code #	Description
100	**AEROSPACE - AERONAUTICAL ENGINEERING**
101	Aerodynamics
102	Automatic Control of Flight Vehicles
103	Digital Computer Controlled Systems
104	Flight transportation
105	Instrumentation Guidance and Control
106	Space Communications
107	Space Dynamics
108	Space Systems and Control
109	Stability and Control of Flight Vehicles
110	Other (please specify)
	AGRICULTURAL ENGINEERING
201	Agricultural Processing Systems
202	Field Machinery Design
203	Forestry
204	Irrigation Technology
205	Soil and Water Conservation
206	Other (please specify)
300	**ARCHITECTURAL ENGINEERING**
301	Architectural Design and Analysis
302	Building Processes
303	City Design
304	Computer Simulation of Architectural Systems
305	Environmental Controls
306	Industrial Building Design

Code #	Description
300	**ARCHITECTURAL ENGINEERING** (continued)
307	Metropolitan Planning
308	Planning for Community Facilities
309	Structural systems, analysis, and design
310	Technology and City Planning
311	Urban Design and Analysis
312	Other (please specify)
400	**BIOENGINEERING**
401	Artificial organs
402	Bioelectrical Signals
403	Bioelectronics
404	Biological effects of Noise
405	Biological membranes and structural tissue
406	Biomechanics
407	Biomedical Heat and Mass transfer
408	Biomedical Materials
409	Biomedical Systems analysis
410	Biophysics of Neurolectric Potential
411	Clinical Engineering
412	Electrocardiography
413	Instrumentation
414	Monitoring with microcomputer systems
415	Sensory Communication
416	Technology Application to Biosystems
417	X-ray diagnosis
418	Other (please specify)

Code#	Description
500	CHEMICAL ENGINEERING
501	Chemical Calculations
502	Chemical Engineering Process - analysis and control
503	Chemical Engineering Process - design
504	Chemical Kinetics
505	Chemical Thermodynamics
506	Combustion and Air Polutions
507	Computer Simulation of Chemical processes
508	Industrial Chemical Processes
509	Petroleum
510	Polymer - Structure and Properties
511	Process Optimization
512	Reactor design
513	Spectroscopy
514	Transport Phenomena
515	Other (please specify)
600	CIVIL ENGINEERING
601	Airport Planning and Design
602	Building design systems
603	Design and Analysis of Concrete Structures
604	Design and Analysis of Steel Structures
605	Earthquake Engineering
606	Engineering Materials
607	Finite element method applications
608	Geotechnology
609	Highway Technology
610	Hydrology - Hydrosystem
611	Mechanics of deformable bodies
612	Satellite and Physical Geodesy
613	Soil Mechanics - Dymanics
614	Structural Analysis and Design
615	Structural Materials
616	Structural Systems
617	Traffic Systems
618	Transportation Facilities
619	Transportation Systems
620	Urban Planning
621	Water Resource Systems
622	Water Resources and Control
623	Other (please specify)

Code #	Description
700	COMPUTER ENGINEERING (see also Electrical Engineering)
701	Advanced Programming: Top-down design and structured programming
702	Computer Architecture
703	Computer Graphics
704	Computer Languages
705	Computer Simulation
706	Data Base Management
707	Information Processing
708	Language Translation and Compiler Construction
709	Machine and Programming Languages
710	Management Systems
711	Numerical Methods
712	Operating Systems
713	Processing Systems - Fundamental Algorithms
714	Software Engineering - Applications
715	Systems Simulation
716	Systems Theory and Design
717	Other (please specify)
800	ELECTRICAL ENGINEERING
801	Antennas and Wave Propagation
802	Artificial Intelligence
803	Bioelectronics
804	Broadcasting
805	Communication Systems
806	Computer Systems design
807	Consumer Electronics
808	Control Systems
809	Cybernetics
810	Digital Systems
811	Electric Machines
812	Electromagnetic compatability
813	Electromagnetic Theory
814	Electron Devices
815	Electronic Devices and Circuits
816	Electronic Instrumentation and Control
817	Electro-optics (fiber optics)
818	Energy Transducers
819	Feedback Control Systems
820	Image Processing
821	Image Transmission Systems
822	Industrial Electronics and Control Instrumentation
823	Information Systems
824	Instrumentation and Measurement
825	Lasers
826	Lightning Protection

Code #	Description
800	ELECTRICAL ENGINEERING (continued)
827	Magnetics
828	Microelectronics
829	Microprocessor Systems Design and Analysis
830	Microwave Theory and Techniques
831	Networks
832	Nuclear and Plasma sciences
833	Operations Research
834	Pattern Recognition
835	Power Systems
836	Programming Language Processors
837	Radar Systems
838	Radio Astronomy
839	Reliability
840	Semiconductor Devices
841	Signal Processing
842	Simulation Methods for Analysis and Control
843	Solid State Circuits
844	Sonar Systems
845	Sonics and Ultrasonics
846	Structure and Translation of Computer Languages
847	Switching Theory and Logic Design
848	Vehicular Technology
849	Other (please specify)
900	ENVIRONMENTAL ENGINEERING
901	Air Pollution Control
902	Air Pollution Systems Analysis and Design
903	Environmental Impact Assessment
904	Environmental Noise Control
905	Environmental Quality Control
906	Sanitary Control
907	Sanitary Systems
908	Wastewater Treatment
909	Other (please specify)
1000	INDUSTRIAL ENGINEERING
1001	Cost Control
1002	Industrial Systems
1003	Manufacturing Processes
1004	Modeling Simulation and System Simulation
1005	Occupational Safety and Control
1006	Plant Design and Layout
1007	Process Control
1008	Production Planning and Control
1009	Quality Control
1010	Reliability Control
1011	Stochastic Models in Operations Research
1012	Other (please specify)

Code #	Description
1100	GENERAL ENGINEERING
1101	Alternate Sources of Energy
1102	Energy and Human Affairs
1103	Engineering and Public Policy
1104	Numerical Methods of Engineering Analysis
1105	Optimization Techniques
1106	Pollution and Environmental Impact
1107	Probabilistic Models in Systems Engineering and Operations Research
1108	Random Processes
1109	Role and Management of Modern Technology
1110	Statistical Analysis
1111	Technological Assessment and Public Policy
1112	Other (please specify)
1200	MATHEMATICS (including operations research)
1201	Coding Theory
1202	Combinatorics
1203	Experimental Design
1204	Graph Theory
1205	Linear Programming
1206	Matrix Theory
1207	Nonlinear Programming
1208	Numerical Analysis
1209	Ordinary Differential Equations
1210	Partial Differential Equations
1211	Queing Theory
1212	Special Functions
1213	Statistical Methods
1214	Stochastic Methods
1215	Other (please specify)
1300	MECHANICAL ENGINEERING
1301	Analysis and Design of Manned Systems
1302	Analysis and Design of Systems
1303	Applications of Numerical Method to Mechanical Systems
1304	Combustion Engineering
1305	Computer Modeling of Mechanical Systems
1306	Control System Principles
1307	Energy Conversion
1308	Fluid Mechanics
1309	Geothermal Energy
1310	Heating - Refrigeration - Air Conditioning
1311	Instrumentation and Control
1312	Materials Processing and Manufacturing

Code #	Description
1300	MECHANICAL ENGINEERING (continued)
1313	Modeling and Simulation of Systems
1314	Modeling of Manned Systems
1315	Solar Energy Generation
1316	Solar Systems - Analysis and Design
1317	Systems Dynamics
1318	Thermal Power Systems - Power Generation
1319	Thermodynamics of Power Systems
1320	Vibrations - Sound and Structural
1321	Wave Propagation
1322	Other (please specify)
1400	NAVAL AND OCEAN ENGINEERING
1401	Computer Simulation of Marine Systems
1402	Energy Conversion Systems
1403	Hydroacoustics - Noise
1404	Hydromechanics of ship design
1405	Marine Resources - Utilization
1406	Marine Structures
1407	Marine Systems Control
1408	Oceanographic Systems
1409	Power and Propulsion of Marine Structures
1410	Power Systems
1411	Propulsion Hydrodynamics
1412	Structural design
1413	Other (please specify)
1500	NUCLEAR ENGINEERING
1501	Computer Simulation of Reactors
1502	Nuclear Fuel Cycle Management
1503	Nuclear Power Plants
1504	Nuclear Power Plants Analysis and Design
1505	Nuclear Power Reactors
1506	Nuclear Reactor Analysis and Control
1507	Nuclear Reactor Operations
1508	Nuclear Waste
1509	Reactor Analysis and Design
1510	Other (please specify)

Code #	Description
1600	PHYSICS
1601	Accelerator Physics
1602	Acoustics
1603	Applied Physics
1604	Astronomy
1605	Astrophysics
1606	Atmospheric Physics
1607	Atomic and Molecular Physics
1608	Biophysics
1609	Chemical Physics
1610	Cosmic Rays
1611	Electromagnetism
1612	Electronics
1613	Electro-optics
1614	Elementary Particles and Fields
1615	Engineering Physics
1616	Fluids
1617	Fusion and Plasma
1618	General Physics
1619	Geophysics
1620	Health Physics
1621	History of Physics
1622	Lasers
1623	Low Temperature Physics
1624	Material Science
1625	Mathematical Physics
1626	Medical Physics
1627	Nuclear Magnetic Resonance
1628	Nuclear Physics
1629	Nuclear Reactor Physics
1630	Optics
1631	Philosophy of Physics
1632	Physical Metallurgy
1633	Physics Education
1634	Polymer Physics
1635	Quantum Mechanics
1636	Relativity
1637	Solid State Physics
1638	Space Physics
1639	Statistical and Thermal Physics
1640	Superconductivity
1641	Surface Physics
1642	X-ray diffraction
1643	Other (please specify)
1700	OTHER AREAS
1701	Accounting
1702	English
1703	Ethics
1704	Psychology
1705	Report Writing & Presentation
1706	Sociology
1707	Other (please specify)